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Monterey, California

Business Re-Engineering:
Lessons Learned From the
U.S. Army Corps of Engineers
Modernization Program

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October 1992

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This study reports the lessons learned from the U.S. Army Corps of Engineering (USACE) Modernization Program. USACE has developed a proven methodology for successfully modernizing information systems. Its experience provides some valuable guidelines for agencies wishing to pursue a successful organization-wide process to deploy information systems.

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CASE STUDY SERIES
ON IMPLEMENTATION PRACTICES OF
MANAGEMENT INFORMATION SYSTEMS
IN THE DEPARTMENT OF DEFENSE

Business Re-Engineering: Lessons Learned from the U.S. Army Corps of Engineers Modernization Program

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I. Executive Summary

Information Technology as a Foundation for DoD Improvement

Almost all organizations these days confront increased demands for efficiency and responsiveness to the markets they serve. Managers of information technology find themselves in the thick of the fray, because most of their organizations are looking to information technology as one of the primary means of coping with worldwide competition. It is difficult to think of any substantial challenge facing these organizations — improved service or product quality, reduced cycle times for all their business functions, improved coordination across far-flung activities, more efficient use of resources — for which information technology does not contribute something to the solution.

With the largest single pool of information technology in the world, the Department of Defense (DoD) is by no means immune from these effects. The dramatic political and military changes that have occurred in the world over the past couple of years call for corresponding changes in the way DoD does business. Leaders within and outside of DoD are challenging each activity to justify its contribution to national defense and to reduce its costs as much as possible consistent with its essential missions. Like most other large organizations, DoD is looking to information technology as a fundamental building block of any long-term improvement program. DoD's Corporate Information Management (CIM) initiative constitutes a critical component of any such program.

USACE — A Leader in Applying Information Technology

An important principle of the CIM initiative is to identify the best practices within DoD agencies so that they can be borrowed and emulated throughout the Department. The U.S. Army Corps of Engineers (USACE) provides just such a model- its business re-engineering strategy. It has, in fact, been recognized by the Director of Defense Information, for a "golden nugget" award that signifies leadership in applying information technology. USACE demonstrates how an agency can effect major changes through the intelligent use of information technology. The Corps strategy appears to be quite capable of being applied in other organization within DoD, the Federal government, and, indeed, the private sector.

USACE and Business Re-Engineering

USACE is the largest engineering organization in the world, with an annual budget of $9 billion. It supports DoD construction activities, handles large civil works programs, and contracts with various governmental agencies to perform a wide variety of civil engineering works. The largest single source of funding comes from the outside contracts, for which it has to compete with private-sector engineering firms. It thus has ample incentive to strive for efficiency and effectiveness.

Through the early 1980's, USACE's experience with computer-based systems was much like many large organizations. A large variety of systems were developed by subgroups within the Corps. This was done with little or no high-level support or direction. The resulting "stovepipe" systems may have met the needs of individual functional groups, but there existed almost no integration across functions. As a result, USACE information systems suffered from a great deal of duplication and inconsistencies, and failed to meet the overall goals of the organization.

In 1982, the General Accounting Office issued a critical report on data processing practices within USACE. The report criticized, among other things, the lack of central direction for Information Systems (IS) activities, the absence of a coherent IS plan linked

to the Corps' missions, the unnecessary duplication of functions and data, and inconsistent acquisition policies for hardware and software.

The USACE Action Plan

The GAO report galvanized USACE into action. By 1984 an Information Systems Plan was issued. It proposed the appointment of the Deputy Commanding General — the second in command of the Corps — as the senior IRM official. An Information Resource Management Steering Committee was established. Composed of 12 high-level functional managers, plus non-voting IS managers, the Steering Committee oversees USACE IS policies. A subset of this committee forms an Executive Committee, which meets weekly to provide continuous policy direction. Supporting these governance bodies are other committees that deal with such matters as defining functional requirements and establishing data standards.

Based on the results of the Information Systems Implementation Plan (ISPI) conducted in 1985, a project slate of proposed candidates for re-engineering were identified. The business processes were to be modernized and applications developed according to an overall plan that set priorities consistent with the most important management needs within USACE. A communications network was proposed to link all USACE locations. Three consolidated regional processing centers were established to serve the organization's centralized computing needs. Data standards were set to facilitate data sharing and reduce data redundancies and inconsistencies.

The Successful Re-Engineering Process

USACE has developed a proven methodology for successfully modernizing information systems. The success results from the synergy of pertinent use of well proven techniques and involvement of all-level personnel in the re-engineering effort. Candidate applications for re-engineering are identified through high-level management committees. Those slated for development, become the responsibility of a relatively

small development team — typically six to eight members — composed of a mixture of functional and technical specialists. The team follows a well-defined process:

- Define the AS-IS existing system to provide a baseline for considering a new alternative.
- Examine each existing activity to determine whether it should be continued, eliminated, or revised.
- Design alternative TO-BE systems.
- Build a business case — a cost-benefit analysis — for each alternative design and select the most cost effective one.
- Develop a transition plan to implement the chosen design.
- Develop a detailed functional design for the application.
- Acquire the application — preferably through a "commercial off the shelf" (COTS) product that meets USACE needs.
- If no COTS is found, install a pilot implementation through an iterative prototyping process that involves careful testing and user reviews.
- Install the application where appropriate, based on a Corps-wide deployment plan.

Lessons Learned

USACE's experience provides some valuable guidelines for agencies wishing to pursue a successful organization-wide process to deploy information systems. Each agency has, of course, its own unique set of requirements and culture. Nevertheless, the general process used by USACE should find widespread applicability. The principal lessons learned, which provide valuable guidelines for other agencies with aspirations similar to USACE's, are as follows:

- Top-management support, combined with support at all levels of the organization, is essential for any far-reaching program of business re-engineering.
- Business re-engineering should precede any attempt to develop new information systems.

- A Business re-engineering STRAP is needed for modernization of any process.
- Heavy user participation — gained through committee arrangements and other mechanisms — is critical at all levels of the development process.
- Top-level functional managers are needed to serve as "executive champions" of an application.
- A well-structured methodology is needed to provide the discipline and guidance for the re-engineering process.
- A supportive infrastructure — effective communications networks and data sharing mechanisms — is an essential ingredient to a successful IS program.
- A strong organizational commitment to sharing the corporate data assets is imperative.

II. Foundations for Business Re-Engineering in DoD

This section serves as a brief introduction to the basic concepts and history that could be considered as foundations of a sound business re-engineering process. These include: Corporate Information Management (CIM), Total Quality Management (TQM), Activity-Based Costing (ABC), and Management of Planned Change. The reader who is familiar with these concepts may wish to skip this section.

A. Towards a Cost-Effective DoD Organization

Facing deep cuts in government defense spending, military leaders in all areas will be challenged to accomplish their mission with a severely limited budget. The costs of the current military establishment must be reduced and effectiveness increased if the scaled-down military of the future is to be fully capable of responding to challenges throughout the world. Military leaders will be forced not only to eliminate waste, but also to make improvements in quality and efficiency. Such an effort calls for a continuously orchestrated improvement process involving all activities of the organization.

Modern management concepts, including CIM, TQM, ABC, and Business Re-Engineering, are widely recognized as critical baseline principles for a modernization program. It is important that DoD program managers understand the essence of these concepts to successfully harness the synergy of management, re-engineering, and prototype application for a more cost-effective DoD organization (Figure 1).

1. The Corporate Information Management Initiative

The CIM initiative, introduced within the Department of Defense (DoD) in October 1989, has been heralded as an initiative to improve standardization, quality, and

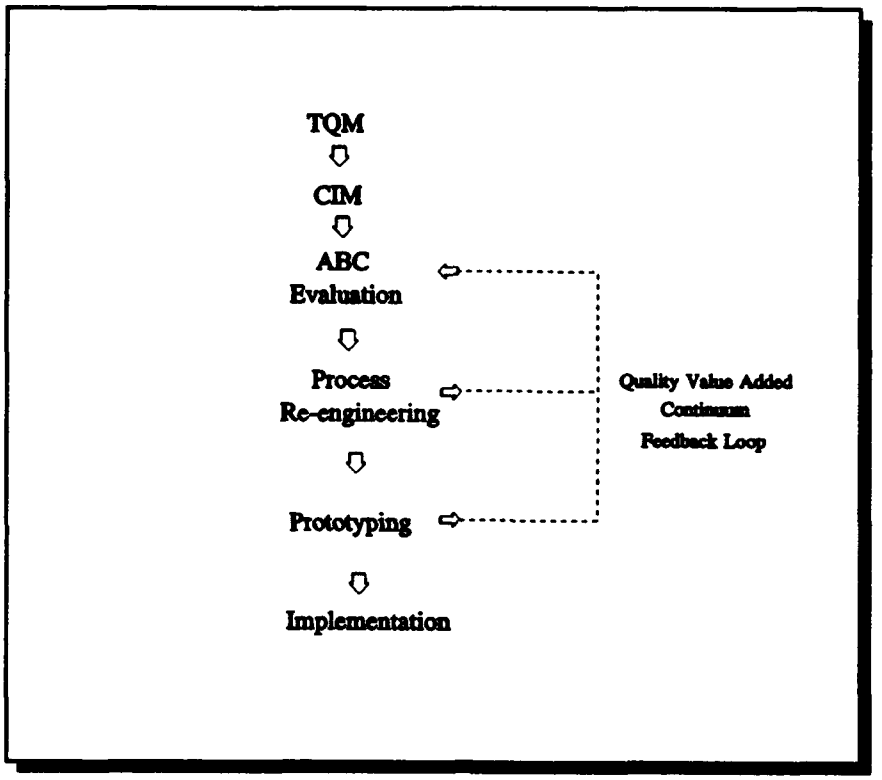

Figure 1 - Basic Building Blocks for Business Re-engineering

consistency of data from DoD's multiple information systems.[1] The program is designed to eliminate redundant information systems and software from distributed administrative areas. Common applications are consolidated into information resource centers that operate under standardized data usage.

Early in the CIM process, DoD formed an Executive Level Group (ELG), comprised of information system specialists from the private sector, to formulate a DoD-wide strategy for downsizing the information resource management structure in response to the shrinking defense budget. The unique aspect of CIM has been its move away from

[1]GAO/IMTEC 91-17BR "Potential Reductions to Defense's ADP Budget Request"

the concept of management of information systems to one of management of information as a valuable resource.[2]

Principle 1: Customer Satisfaction

- Your Customer — the function with business process authority and performance accountability — defines systems requirements, manages implementation and measures results.
- An information resource organization becomes a fee for service technology service center.

Principle 2: Simplification of Processes Before Computerization

- The business process must be simplified before it is computerized.
- Apply technology only after you are sure the organization can manage the proposed change.
- Increase effectiveness and reduce cost of the process by changing how people work.

Principle 3: Implementation of Systems Through Prototyping

- The fastest process, at the lowest risk, is through evolutionary improvement of the process.
- The best learning environment is achieved through frequent success.

Table 1. CIM Principles

[2]Logistic Systems Architects (LSA) White Paper on CIM, USACE.

CIM is founded on three basic principles: customer satisfaction, simplification of processes before computerization, and implementation of systems through prototyping (Table 1). Implementation of these principles should result in achieving the quality value-added continuum shown earlier in Figure 1.

The ELG strategy for information management emphasizes a centralized program for data standards and process modeling. Data standardization facilitates data sharing and provides a clearer view of how information is used within a process. Standardizing a data element implies that information must be handled efficiently at a low cost in order to preserve its added value to the organization. Through its guidelines, the CIM initiative insists that information must be used to simplify the way DoD does business.

The business process must be simplified before it is computerized. According to CIM guidelines, an organization should:

- Seek a non-computer solution through process simplification and elimination of non-value added steps
- Re-engineer existing systems
- Use proven system applications
- Use 'off-the-shelf' software and systems
- Develop systems that have joint-service applicability
- Use service-unique systems only if the above guidelines will not meet the requirements.

The key objectives are to identify and establish information requirements, data definitions, and formats that allow standardization of automated data processing (ADP) systems throughout DoD.

Ideally, once data standardization is achieved, ADP systems that perform similar functions can be integrated into systems that share resources. The following eight functional areas have been identified as candidates for integrated information management and cost savings:

- Civilian payroll
- Civilian personnel

- Contract payment
- Financial operation
- Government furnished material
- Medical services
- Warehousing, shipping, and distribution centers.

Other areas within DoD (e.g., Command and Control) that might serve as candidates for the CIM initiative are being evaluated.

The Department of Defense has an annual budget of over $9 billion to acquire, maintain, and operate general-purpose ADP systems. It is estimated that $4 billion of this amount is spent to develop new computer-based applications and upgrade existing systems. An effective use of information technology (e.g., business re-engineering, structured analysis and design tools, application generators, etc.) is expected to save approximately 25 percent of the system development and procurement costs.[3] Additional savings can be realized in the future through the operation and maintenance of fewer, more integrated systems.

In anticipation of a potential $1 billion savings in information systems development and acquisition costs through CIM, the Office of the Secretary of Defense (OSD) has begun a five-year phased reduction of ADP budgets for all member services. The plan calls for a $100 million reduction in fiscal year 1991, $200 in 1992, and $300 million in years 1993 through 1995.

2. Value-Adding Strategies for Information Systems

The ELG has identified the following value-adding strategies for information systems:

- Use re-engineering methodologies (e.g., process and data models) to determine joint use application.

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[3]GAO/IMTEC 91-17BR

- Employ tools to measure effectiveness and efficiency that compare public and private sector business processes and determine future direction for information systems.
- Establish a fee for information service as a way of determining system efficiency.
- Promote the development of information systems with open system architecture to free DoD from proprietary constraints on hardware and software.
- Enforce data standards to achieve full conformity with Federal Information Processing Standards and the Commerce Department's National Institute for Standards and Technology (NIST).
- Manage information resources to allow rapid deployment of new technology.
- Educate all establishments within DoD on CIM goals and objectives.

B. A Framework for Business Re-Engineering

1. Total Quality Management (TQM) in DoD

Total Quality Management / Leadership (TQM/TQL) rests heavily on the teachings of W. Edward Deming. Deming's approach to quality control is more than a scientific method to improve a worker's speed of productivity.[4] In recognition that quality has become a key competitive factor, organizations must be responsive to customer needs, concentrate on improvement of process as the never-ending business of the enterprise, and promote teamwork among those who carry out the business operations. The relationship between improved quality and overall business-success in an organization is shown in Figure 2.

As tangible ways to improve and measure quality, *statistical indicators* (e.g., trend and variance analysis) provide feedback that show the effects of change. TQM utilizes seven graphic tools for measuring and explaining process quality improvement (Table 2). The benefits derived from these graphics tools fit well with the four phases

[4]Deming defines quality management as "...understanding the customer's needs and providing a product that meets his satisfaction." The "best return" on each dollar spent is the goal.

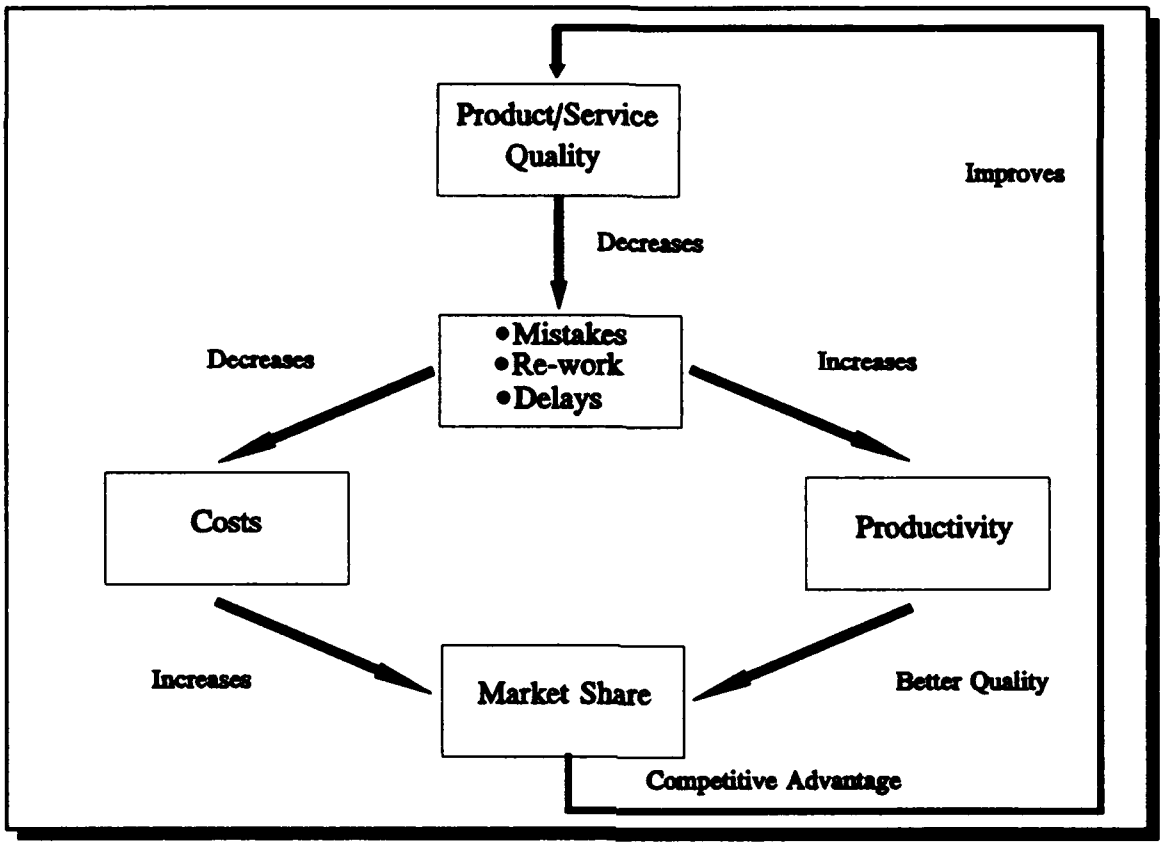

Figure 2. Quality Contributions to Business Improvement

(Add-Plan-Do-Check) of the Deming quality improvement cycle (Figure 3). The cycle ideally should remain in an endless loop, ever monitoring and improving the quality of the process.

It is important to note that quality control measurements are meant to be a tool for change. Unexpected problems could arise if management by numbers became the only motivation for applying statistical quality control.

DoD seeks to spread TQM concepts to the field with leadership geared to change (TQL). Management leadership is critical to bringing about necessary cultural changes and improve quality within DoD organizations. To achieve this goal, upper DoD management has formed an Executive Steering Group (ESG) whose mission is to develop the strategic goals of TQM for the organization.

FLOW CHART	Promotes understanding between value and cost added steps.
CAUSE & EFFECT DIAGRAM	Relates positive and negative effects that cause variance in quality.
PARETO CHART	Bar graph to simplify large data tables providing basis for identifying problem areas.
HISTOGRAM	Bar graph represents the amount of variance between results and specifications.
SCATTER DIAGRAM	Indicates how changes in one variable are related to changes in another variable.
RUN CHART	Identifies patterns of performance for changes in progress.
CONTROL CHART	Reveals cause and statistical control of variations from standards, along with process capability.

Table 2. Graphic Tools for Measuring Quality Process Improvement

2. Activity Based Costing

The CIM initiative stresses cost containment and the elimination of activities that do not add value to the business process. Activity Based Costing (ABC) holds promise as being an invaluable tool in evaluating and containing costs.

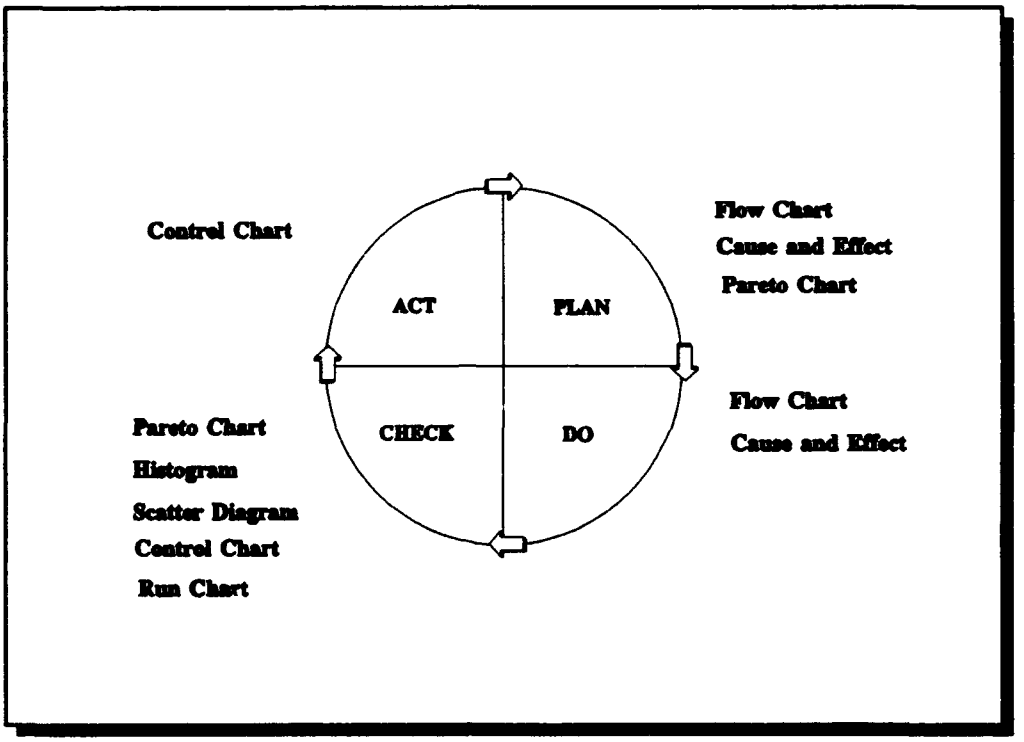

Figure 3. Graphic Tools Associated with the Quality Improvement Cycle

a. The Illusion of Cost Savings

Supporters of ABC management aggressively argue that traditional methods of cost accounting dwell too much on past accounting data in trying to make future improvements. ABC as a managerial approach is in stark contrast to traditional cost accounting methods that see cost only as a function of output volume. Traditional cost accounting techniques examine where monetary resources are expended. Management may use such information to determine where budgets can be trimmed to reduce overall expenditures within the company. Budgetary reductions often focus on downsizing the work force, pay cuts, forced early-retirement, or elimination of research and development efforts. The loss of a skilled work force, combined with reduced product research and development effort, invariably leads to a reduction in product quality. Cost cutting measures, in reality, often present only a "surface patch" to a deeper budgetary problem.

The illusion of reduction in operating expense exists, but organizational performance decreases due to inferior quality standards. There is only further temptation to increase the cost cutting measures to give the Profit & Loss statement another short-term gain. Meanwhile, quality issues remain unaddressed. Improving the appearance of the income statement often does nothing for an organization's attempts at maintaining its objectives. What is needed is a cost management methodology that examines not only where cost are incurred, but also how they are incurred.

b. Value-Added Awareness

Consistent use of ABC management provides a measured approach to cost reduction. The overall cost often depends on decisions made across department boundaries. Across-the-board cost cuts do not adequately address the interrelation of the costing decisions. The focus should be on the elimination of those costly activities that do not add value, rather than making indiscriminate cuts.[5]

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[5]An example of the value-added awareness in the production process using activity based costing is provided by the Tektronix Company's Portable Division, a manufacturer of portable electric measuring devices (Shank, p.47). In the face of increased competition for market-share, the organization formulated plans to change the way it made its products. Tektronix found that traditional cost accounting techniques were "obsolete and restrictive." They were scrapped in favor of a cost management system that Tektronix called "accounting for continuous improvement."

The result was an evolutionary overhaul of the previous cost accounting system that led to the elimination of the following activities:

- The production work order system
- Standard product cost calculations
- Cost variance reporting
- Flexible budgets procedures for cost control
- The scrap and rework reporting system
- Monthly inventory tracking & reporting
- Accumulation of work in process (WIP) inventory cost
- Monthly summaries reports of financial performance.

These activities added no increased value to the finished product. They involved redundancies in accounting for materials used, logging waste that should not occur in the first place, inspecting inefficient procedures instead of correcting them, and producing intermediate status reports. Many of these activities were replaced with more modern reporting procedures that provide management *real time* cost analysis information that allows an organization to make realistic decisions on production cost.

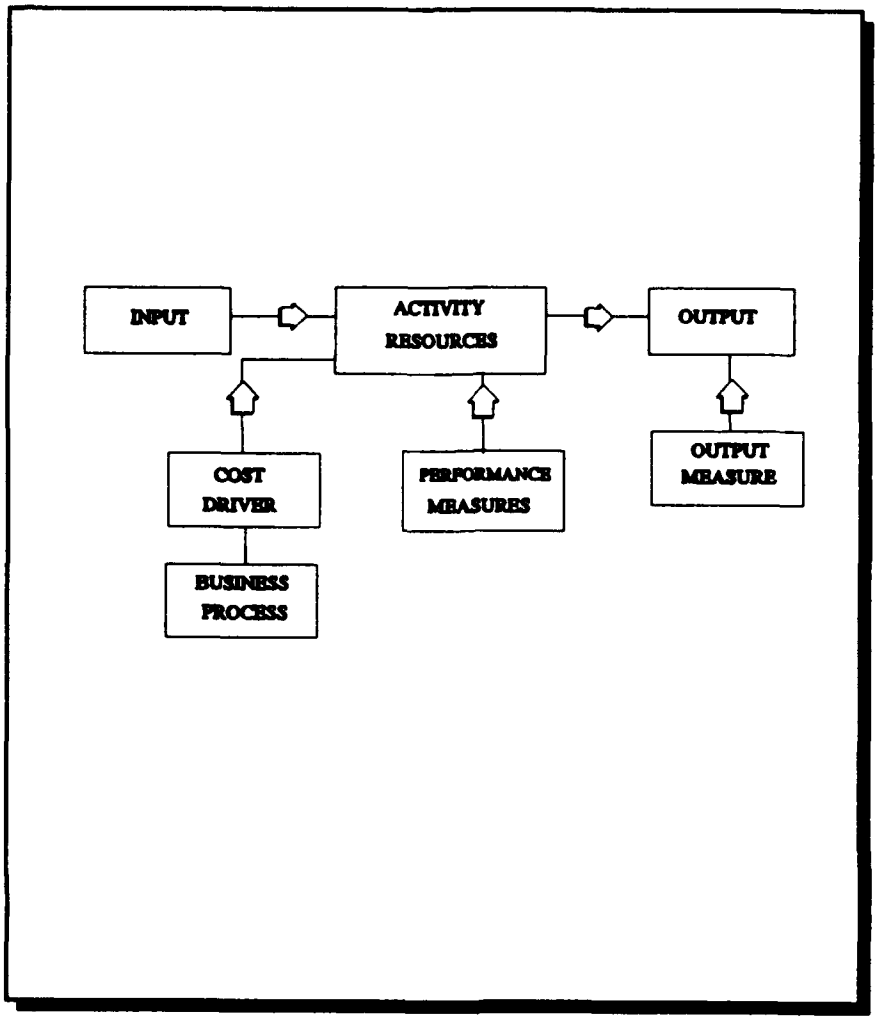

Figure 4. Analysis of Business Activities Based on ABC

Effective cost management needs to look not only at the cumulative monetary amount spent on the product manufactured, but also at the cost of the individual processes, or activities, in the production operation (Figure 4). This allows management to isolate activities within the production process and evaluate whether certain activities are cost-efficient and add sufficient value to the product.

Activity-Based Cost Management fosters evolutionary change to occur in the production process. As cost drivers, activities that are obsolete must be eliminated from the process and, if necessary, replaced by alternative procedures. The organization can continuously modify activities as part of its cost driver monitoring effort.

3. Management of Planned Change

Affecting change within a large-scale corporate structure is a complex and traumatic process that involves risk, uncertainty, and resistance. However, change is necessary if an organization wishes to remain competitive. For a planned change to be effective, a large-scale organization such as DoD must take into consideration its size and cultural history, depth of change in the organizational hierarchy, and whether the change crosses functional areas.

Areas where change offers substantial opportunities for improvement include:

- Better relationship between the organizational culture and the competitive environment
- Refinement of the input-output transformation process
- Improvement of product quality
- Differentiation, coordination, and integration of effort across functions
- Human resource management

With the key areas of change identified, management must realize that designing and implementing a planned change involve re-formulating corporate strategies and structures, incorporating new technology (including the use of information technology), and re-evaluating employee development programs. Procedures to promote information exchange, enhance decision making and conflict resolution, and encourage participation and cooperation between functional areas should be carefully designed and implemented during the change process.

4. Business Re-Engineering

The history of business re-engineering began in the early 1980's in the manufacturing sector. Concepts such as Just-in-Time (JIT) inventory and concurrent engineering were developed and often supported by sophisticated computer systems. Organizations were forced to carry out new business methods, rethinking the way they operated.

Business re-engineering is based on the concept that organizations must change the way they work in order to effect a major improvement. By breaking down operations into manageable and discrete processes, the organization can identify activity areas for elimination or improvement. From this point of view, re-engineering is a logical outcome of ABC, TQM, and management of planned change.

Re-engineering involves three steps:

- Examination of the business process
- Optimizing the process for efficiency
- Implementing a new business system (applying information technology when appropriate to the new process).

An effective way to carry out a program of re-engineering is to assemble a team that is composed of members representing a broad range of functional areas within an organization. The team should analyze existing business processes and activities in an attempt to fully understand the current operations.

Once the current business activities are fully understood, the re-engineering team begins to optimize them for efficiency and effectiveness. Graphical and statistical tools (such as those used in TQM), ABC , and common sense are applied to assess whether an activity adds sufficient value to justify its continuation. The basis for establishing a new business process is to enhance the value-added activities and eliminate the remaining ones. This approach systematically creates new rules, and a need for modernization. Table 3 lists a set of guiding principles for re-engineering.[6]

5. Re-engineering — Go Versus No-Go

The decision whether to revamp a business process or to "leave it as is" can be very traumatic for most organizations. Talk of any change is often a source of contention as to the best path for process improvement. Knowing when to re-engineer a business process is perhaps more crucial than the mechanics of knowing how to do it.

[6] Hammer, pp 108-110.

Thinking that re-engineering is a panacea for any business process is a trap that must be avoided. For this reason, the decision to re-engineer an existing process must not be made lightly.

The following provides some guidance as to whether or not an organization should re-engineer:[7]

- The support of top management must be the first factor affecting whether or not an organization should engage in a re-engineering program; without such support, any fundamental change is almost impossible.

- Processes that are critical, or of the greatest value, to the organization's mission should take precedence over the ones that are perceived as having less strategic impact.

- It is usually not cost effective to re-engineer a process that will soon be phased out. Expected benefits of a re-engineered process may not be able to offset the conversion costs.

- The greater the complexity of a process, the more attractive it becomes as a candidate for re-engineering. The complexity of a process may stem from its intrinsic nature — e.g., the process may involve a large number of variables and complicated or probabilistic relationships among the variables. Re-engineering may often exploit information technology to deal internally with the complexity, thereby reducing the apparent complexity as seen by the user — "so complex, it's easy," as proclaimed by the ad for the automated camera.

- An old process that has undergone continual changes and accretions often presents an excellent opportunity for re-engineering. An activity that may have started out as a clean and simple process gradually becomes more and more convoluted with appendages to handle "special cases" and "extensions." Re-engineering can often sweep away this *accumulated complexity* by simplifying the process and eliminating unnecessary functions.

- Although complexity is a difficult phenomenon to measure, experience has shown that the more individuals involved in a process the more complex that process is; therefore, there is a greater possibility that this process contains non-value adding steps.

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[7]Sittenauer and Olsem of the USAF Software Technology Support Center have constructed a self-assessment survey to aid in the decision when to conduct a software re-engineering effort ("Time to Re-engineer?", Cross Talk, March 1992, p.21).

- Re-engineering is most successful when applied to one process at a time. Attempts to change all facets of the business process at once must be avoided.

- The selected candidate process for improvement will be most successful if the organization can nurture a consensual decision-making environment. This allows shareholder commitment to the re-engineering effort.

WHO SHOULD RE-ENGINEER?

- Non manufacturing firms and high technology firms facing tough competition
- Companies in need of a radical product breakthrough
- Companies under fire from heavy end-user demands
- Companies facing financial crisis

PRINCIPLES OF RE-ENGINEERING

- Organize around outcomes, not tasks
- Have those who use the output of the process perform the process
- Subsume information processing work into the real work that produces the information
- Treat geographically dispersed resources as if the were centralized
- Link parallel activities instead of integrating their results
- Put the decision point where the work is performed, and build control into the process
- Capture information once and at the source

Table 3. Guiding Principles for Re-Engineering

In summary, DoD has recognized business re-engineering as a means for streamlining business operations. DoD agencies must not simply automate existing inefficient business processes; they must completely change the way they operate. Information technology is generally an important vehicle to implement change. The Corporate Information Management Program reflects this approach.[8]

[8]"The focus of CIM is on management methods and its primary objective is business process improvement." - White Paper on CIM, Federal Computer Week, September, 1991.

III. USACE: Re-Engineer or Perish

A. USACE and DoD Business Re-Engineering

The Army Corps of Engineers is the largest engineering organization in the world, employing approximately 43,000 civilians and 900 military personnel worldwide. It has a history that spans over two hundred years. Its military districts are depicted in Figure 5.

The USACE mission embraces three major arenas: military construction, civil works, and engineering and project management support to agencies within the federal government and governments of other nations.[9]

Among other things, USACE is responsible for construction on both Army and Air Force bases. It is currently undertaking projects that coincide with the implementation of the Base Realignment and Closure Act of 1988. In 1990, USACE spent $50 million on these activities and estimates that it spent the same in 1991. USACE is also responsible for providing new facilities at the installations that will be gaining forces as a result of this Act.

USACE also participates in a large civil works program. This includes water resource management and emergency response. As part of water resource management, USACE maintains 25,000 miles of inland waterways and approximately 100 major seaports, as well as smaller harbors. These waterways are critical to the movement of

[9]The general mission of the Corps is "To manage and execute engineering, environmental, real estate, research and development, and readiness programs to support the Army, Department of Defense, and the Nation during peace and war. Inherent in this mission is providing caring leadership and quality products and services consistent with environmental values and the highest standards of professional integrity and excellence."

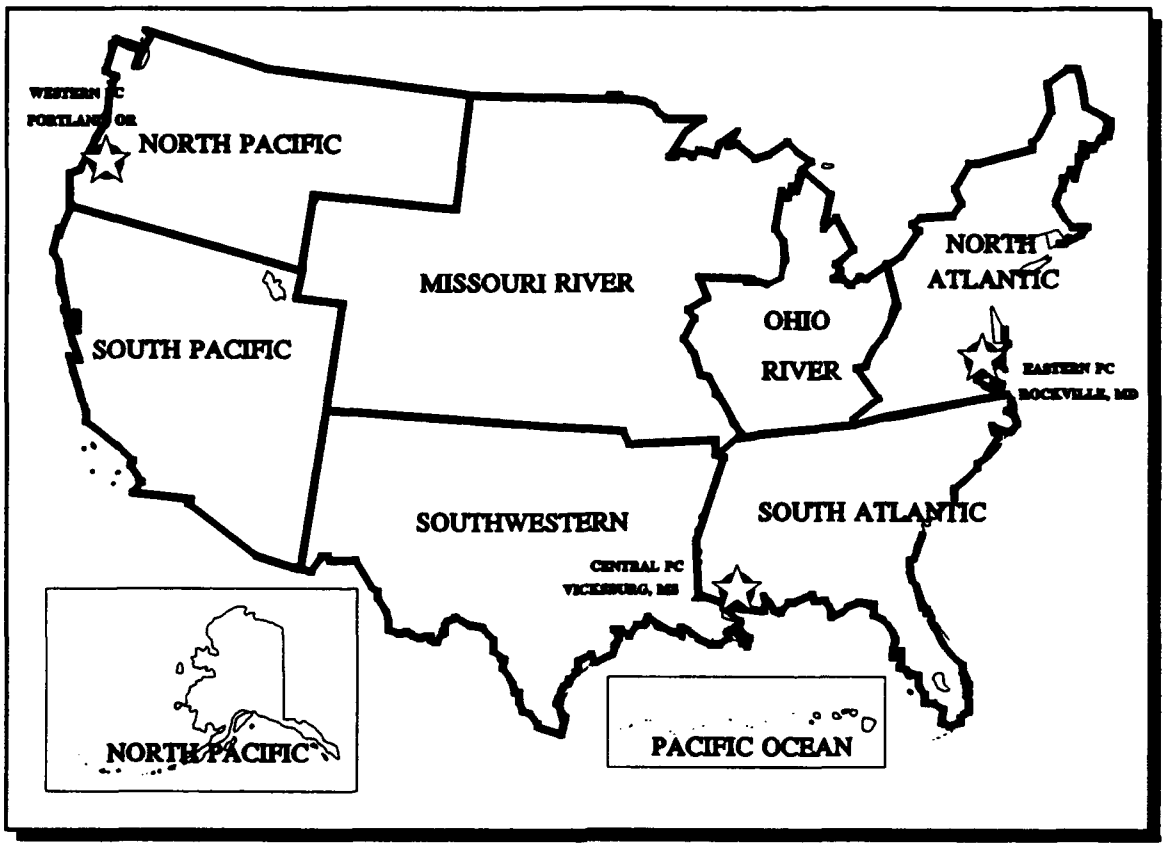

Figure 5. USACE Military Districts and Regional Processing Centers (Note - Civil Works Boundaries are not Depicted)

commercial and military traffic. USACE constructs and maintains locks and dams, as well as dredges navigable waterways. Its Emergency Response Teams assist in areas stricken by flood, drought, tornadoes, volcanic eruptions, or similar natural disasters. They conduct rescue operations, restore vital transportation links, and restore essential resources (such as drinking water) to areas suffering such disasters.

Projects for federal agencies include construction of space shuttle launch and landing facilities for NASA, bulk mail facilities for the U.S. Postal Service, transmitters for Voice of America, and facilities for the Department of Energy. Projects for governments of other nations vary. Most recently, USACE was involved in the Kuwait recovery program following Operation Desert Storm.

The current USACE total annual budget is $9 billion. In 1990, $354 million was spent on information technology, and $7 million was spent on the Information Systems Modernization Program.[10] Budgetary support for USACE missions comes from three distinct sources. Operations and Maintenance (O&M) funding provides direct appropriations for military operations. Civil funds finance the civil works mission of USACE. The third and most significant source of funding is the money received through reimbursable programs. These funds are received through the awarding of contracts to USACE by agencies within the federal government and the governments of other nations. To win reimbursable projects, USACE competes with private sector construction firms and must sell its services to federal agencies.

An adverse GAO audit in 1982 forced USACE to change the way it managed information systems. USACE commenced a massive information systems improvement plan encompassing all areas of information management. Beginning in 1983, a comprehensive program was devised for modernizing hardware, software, and the acquisition and management of information systems.

With business re-engineering as an essential facet of this modernization effort, USACE wants to be a pioneer that serves as an excellent model for CIM.[11] In April 1991, USACE proposed the following nine information systems as interim candidates for potential DoD-wide application:

- Computer Aided Cost Estimating System

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[10]Interview with Mr. Dave Spivey, Information Modernization Program Manager, Dec 18, 1991.

[11]"As the CIM model agency, The Corps would establish a program to assist DoD organizations and agencies in transitioning to CIM from a functional point of view. Our experiences and lessons learned in executing a CIM like philosophy over the years places us in a unique position to assist other organizations with their modernization efforts. We already have in place many of the supporting mechanisms needed to support others, and we have often been called upon to assist Army, DoD, and other government organizations with technical support and advice concerning their information programs. To our knowledge, we are the only organization in DoD to have undertaken this type of program on an agency-wide basis." Memorandum from USACE to Director of Information Systems for Command Control and Computers dated 15 April 1991, proposing USACE as CIM model agency.

- Automated Review Management Systems (ARMS)
- Computer Aided Design and Drafting (CADD)
- Architect Engineering Contract Administration Support System (ACASS)
- PC Economics Package (ECONPAC)
- Real Estate Management Information System (REMIS)
- Integrated Facilities System - Micro (IFS-M)
- Construction Contractor Appraisal System Support (CASS)
- Corps of Engineers Automated Legal System (CEALS)

These candidates meet CIM system principles and have been approved for use throughout USACE.[12]

Based on proven systems development techniques, USACE has developed a structured approach to business re-engineering. The business re-engineering methodology is a generalized and repeatable process that can be taught and implemented effectively.[13]

By adopting an adaptive and participatory approach to implementation, USACE has enjoyed some early success in dealing with the issue of training, corporate change, and all of the challenges associated with the introduction of new business practices in the work place. The lessons learned will benefit all organizations desiring to utilize the USACE business re-engineering methodology.

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[12]All systems developed under CIM are characterized by the following principles:
Vendor independent
Assembled from standard components
Interoperable
Single point data entry
Non-redundant databases*
Developed using a Life Cycle Management Philosophy

* In some instances the USACE modernization program incorporates planned redundancy.

[13]This methodology has been described as a "gold nugget" by Paul Strassmann, Director of Defense Information, who stated, "We will export the Corps of Engineers Methodology throughout the Defense Department." - White Paper on CIM, Federal Computer Week

B. Organizational Culture and Management Philosophy

The Army Corps of Engineers organizational culture is comparable to that of a large and successful private sector corporation. USACE has evolved over its long history into an elite organization with a "can-do" attitude towards any and all missions assigned, striving to be the best and a leader within DoD.

Top management philosophy within USACE is strategic and visionary in nature. Senior USACE officials have identified "corporate effectiveness" as the most strategic issue effecting USACE today.[14] The increased effectiveness of operations is essential in an era of decreased government spending. The major elements of corporate effectiveness for USACE are:

- Human Resources
- Leadership
- Performance Accountability
- Corporate Reorganization and Project Management
- Innovation
- Management of Information.

In order to exploit fully the power of available technology, USACE recognizes that it must continue to make fundamental changes in the way USACE and DoD approach work. In the past, information systems were developed to serve separate functional areas, with each area building its own vertical ("stovepipe") systems that use their own data and imposed almost impenetrable barriers to sharing across systems. Information is now recognized as a common resource that must be used to streamline operations and change the way business is conducted. Although information technology does not *drive* change, it *enables* USACE management to communicate knowledge and integration of data in new ways. The ability to access correct information at the right time is crucial as both USACE and DoD become more cost sensitive. Its new

[14]Modernization Plan

technology and development methodology enables USACE to move toward comprehensive systems that allow information sharing throughout the entire organization.

C. Historical Overview of Information Systems prior to Modernization Efforts

Prior to the modernization effort, USACE information systems consisted of approximately 300 computer-based systems to support administrative functions and over 10,000 applications to aid scientists and engineers in structural and architectural design, research projects, and problem solving. While the scientific and engineering applications were up to standards and followed sound professional practices, USACE realized that improvement was necessary in the business practices underlying management information systems.

1. Philosophy towards Management Information Systems prior to 1982

The standard Corps of Engineers Management Information System (COEMIS) was developed in 1968. Table 4 provides a list of information systems included in COEMIS. These information system applications were used by USACE personnel worldwide, and had become increasingly important to the effectiveness of the USACE mission.

USACE did not always view information as a valuable resource that can be harnessed to increase the effectiveness of an organization. Preoccupied with growth issues, top management within USACE did not provide necessary mechanisms — planning, control, direction, and funding — to ensure that information resources were effectively utilized.

In 1982, the management of information systems within USACE was disparate and inconsistent. Dispersed organizations within USACE were permitted to manage, acquire, and use computers in the way they saw fit. ADP management responsibilities were widely dispersed among the central office, various program offices, and field offices in divisions, districts, research centers, and laboratories. There was no real

SYSTEM	FUNCTION
FINANCE AND ACCOUNTING	Covering all district level accounting records for civil, military, and revolving fund accounts.
PERSONNEL ADMINISTRATION	Database for staff management requirements and authorizations.
RESOURCE ALLOCATION/ PROJECT MANAGEMENT	Reports project management information available in the personnel and finance and accounting data files.
OTHER SYSTEMS	Transportation Information System, Computer Aided Engineering and Design, Progress and Divisions reporting system.

Table 4. USACE Information Systems Prior to 1982

central authority for managing resources. The Engineering Automation Office was established as a central point of management for ADP, but it was given no clear authority over the smaller district offices. As a result, any attempt to enforce a centralized policy was frustrated by the decentralized management structure.

2. Effects of Disparate Management Philosophy

USACE had numerous ADP activities dispersed worldwide, accompanied by inconsistent, incomplete, and ineffective planning. According to GAO, the systems that did exist appeared to be fragmented and ineffective, the use of computer equipment

throughout USACE was inconsistent, and attempts at acquisition of modernized equipment were futile. Table 5 summarizes the findings of a GAO report in 1982.[15]

GAO FINDINGS
• No single focus of responsibility or coherent system for managing information resources
• Lack of a formal oversight mechanism to ensure effective and efficient management and use of information systems and computer software
• No policy for enforcing control of the development of software applications
• No comprehensive plan to help manage, acquire, and use information resources
• No uniform method for evaluating the use and performance of computers and related information resources.

Table 5. Shortcomings Identified in GAO Audit

[15]Because of continual requests for increased funding for information systems by USACE, the House Appropriations Committee requested that GAO conduct a detailed investigation of USACE information systems management (GAO/CED-82-83). The audit was intended to answer the following questions:

- What was the current status and cost of resources in USACE?
- Did the USACE have an effective management control system for its ADP resources?
- Was there adequate management control and conversion planning for computer software?

This audit highlighted several shortcomings in USACE management of information resources as depicted in Table 5. These were a direct result of the inconsistent management philosophy practiced by USACE.

Most notable was the observation that there were no uniform or standardized procedures for systems development. Although USACE had attempted to standardize and monitor systems development by requiring that any development expense in excess of $10,000 be approved by the Engineering Automation Office, there were no mechanisms in place to enforce the policy. For the most part, systems planning took place within separate directorates, with no structured methodology in place to integrate system development.

This fragmented approach led to the creation of vertical un-integrated "stovepipe" systems designed to meet the specific needs of departmentalized functional areas. Some critical data were unavailable at the corporate level; when available, they were either redundant, inconsistent, or inaccessible. Programs were cumbersome to run, with overlapping modules.

The findings of the audit led to a compilation of a list of comprehensive recommendations for improvement (Table 6).

D. Transition to CIM

The basic philosophy and fundamental principles of the USACE program for Information Resource Management were outlined in March of 1983. The objective of the IRM program was to improve the accuracy, completeness, availability, timeliness, and usefulness of information for decision makers at all levels. The time line of this program is depicted in Table 7.

In June of 1984, USACE completed an Information Systems Plan (ISP) for the Office of the Chief of Engineers, presenting the results of a pragmatic, step-by-step review of USACE information systems.[16] Three objectives were identified: relate information requirements to mission, goals, and information systems; recommend strategies to improve IRM; and develop an action plan for improvement. Through a

[16]"Information Systems Plan for the Office of the Chief of Engineers", June 1984.

GAO RECOMMENDATIONS
• Establish a separate Information Resource Management Office at the Headquarters level with clearly defined authority over information resource activity. The head of this office should be designated by the Chief of Engineers.
• Direct the senior IRM official to develop and implement a comprehensive program for managing US.ACE information resources.
• Establish a comprehensive planning process for information resources.
• Systematically update and define functional user requirements to better justify the acquisition of additional computer resources, and determine requirements of communication.
• Perform a detailed review and analysis of major software systems to determine whether they should be continued, redesigned, or eliminated.
• Conduct a thorough cost/benefit analysis of alternative redesign stratagem for USACE Management Information Systems to assure that the Government incurs the lowest total life cycle cost.

Table 6. GAO Recommendations

series of interviews with 55 functional managers, a consensus was reached on key IRM issues that must be addressed in the modernization program. Table 8 lists these issues in order of priority. The team realized that these issues must be effectively addresses in the modernization program (Table 9).

Following completion of the ISP, the Chief of Engineers directed that an Information Systems Planning Implementation (ISPI) report be written dealing with the integration of information systems within the Office of the Chief of Engineers.[17] Completed in May of 1985, the report developed application, data, and geographic

[17]"Information Systems Planning Report: A Prescription for Change", May 1985.

TRANSITION TO CIM

1982	GAO Audit
JAN 1983	Modernization Goals and Objectives Outlined
JUN 1984	USACE Information System Planning Report Published
AUG 1984	Information Resource Management Steering Committee Established
SEPT 1984	Director of Information Management Established
MAY 1985	USACE Information Systems Planning Implementation Report Published
MAY 1986	Comprehensive Business Re-Engineering Program Commences
DEC 1989	12 Requirement Statements Completed
1990	26 Prototype Modules Completed
AUG 1990	USACE 1995 Architecture Developed
PRESENT	10 Modules Deployed

Table 7. CIM Transition Timeline: Some Notable Actions

architectures for USACE-wide information systems.

The report contained three major sections. The first was a tactical plan that contained recommendations as to how USACE could adjust its current systems planning methods to provide for greater integration within the framework of the recommended architecture. The plan recommended a reorientation of existing resources to provide for

Problem Category	Manifestations
Lack of/or incomplete automated system	No automated information system available to satisfy a perceived need or a system substantially inadequate.
Lack of usefulness	Provides information in quantity or format that is either not desired or not needed.
Inadequate ADP assistance	A lack of command direction, central database administration, or programming capability prevents effective automation.
Unreliable area	Data are not accurate or consistent.
Redundancy of data and systems	Same data are maintained in more than one system, and several systems are designed to provide the same information.
Untimeliness of output	Data are received too late to be useful in understanding program status or effecting changes.
Incompatibility of automated system	Communications among information systems are restricted by hardware, software, or data design differences.
Lack of interactivity	Users are not able to manipulate or select data from USACE standard information systems.
Inadequate ADP system awareness	Insufficient training for users of automated systems and a lack of aggressive orientation into existing systems, which restrict the widest use of automated data.
Lack of information	No system exists — automated or non-automated — to provide the required information.
Inadequate non-automated systems	Non-automated systems exist, but are inadequate
Technically inadequate ADP systems	A lack of ADP hardware, software, and/or communications capability prevents effective automation.
Proprietary systems	"Owners" of automated systems resist the sharing of "their" data with others.
Resource Costs	Costs verses benefits are difficult or impossible to identify.

Table 8. Key IRM Issues Identified in ISP

AREA	RECOMMENDATION
Education of Executives	Implement an intensive program of education concerning automation, software, interactive capabilities, ADP cost effectiveness, and information management.
Management of Information/ Automation	Establish a strong support organization for information resource management. Implement an Information Resource Management Directorate headed by a General Officer or Senior Executive Service Civilian.
Existing System Deficiencies	Integrate existing systems across functional organizations.
Lack of Automation	Automation should be developed where needed. Personnel and manpower databases and office automation support should be improved.
ADP Assistance	Improve coordination and teamwork between ADP community and USACE managers.

Table 9. Recommendations by ISP Team

coordinated information and system planning of major systems under the direction of the Information Resource Management Steering Committee created in August 1984.

The second major subsection of the ISPI report was the project slate. The report identified applications that should be redesigned to make them more consistent with the proposed architecture and more useful to management. Seventeen system design projects were identified and ranked in order of importance based upon potential benefits, impact on the organization, probability of success, and demand for use (Table 10).

PROJECT SLATE (Ranked by Priority)	
1) Finance and Accounting	10) Real Estate
2) Manpower	11) Procurement & Supply
3) Design Tracking	12) Civil Works Operations
4) Construction Tracking	13) Administrative Support
5) Civil Works Program Development	14) Strategy, Goals & Objectives
6) Data Dictionary	15) Army Facility Program & Budget
7) Command Operating Budget	16) Performance Measurement
8) Civilian Personnel	17) Safety
9) Plant Replacement and Improvement Program (PRIP)	

Table 10. Project Slate

The third area of the ISPI report was the information architecture review. Detailed architectures designed to serve as a framework for future systems development were defined. They were intended to be used as a tool for planning and coordinating information needs over the life of the Information Systems Modernization Plan.

In May of 1986, USACE began a comprehensive business re-engineering program adopting the Structured Requirements Analysis Planning (STRAP) Methodology that was aimed at building shared data systems. From the ISP project slate (Table 10), eight business processes were identified as a priority for systems re-engineering (Table 11). These business processes were systematically reviewed and restructured utilizing the USACE methodology for business re-engineering. This methodology has proved itself to be very successful, and is the primary focus of this report. The process of re-engineering continues today throughout USACE.

CRITICAL BUSINESS PROCESSES	
• Project Management	• E-MAIL and Encyclopedia
• Financial Management	• Contracts and Databases
• Real Estate	• Employee Data Extract
• Programs Management	• PAX Data Extract

Table 11. Critical Business Processes

1. USACE Corporate Architecture Strategies

USACE formally adopted a new information architecture with the target goal of complete implementation by 1995.[18] The primary emphasis of the new architecture is on a communication network with increased information access, interconnectivity, and consolidation of data centers. USACE organizations and field offices will be able to access the network from remote sites through a device interface (DI), a remote job entry device, or gateways. The data centers located in Vicksburg, Mississippi, Rockville, Maryland[19], and Portland, Oregon will form the crux of the network and will be linked by a common telecommunications backbone. Application programs will be shared among USACE agencies, and will be accessible by several functional users simultaneously. There will no longer be overlapping development of separate systems by functional elements within USACE.

As a result of the interconnectivity discussed above, databases and applications will be shared and centralized. USACE databases will be dynamic and contain standard data elements that will be used by all functional elements within the organization. In the new architecture, data are viewed as a resource separate from applications. These data

[18]"Information Planning Guidance: Towards building the 1995 Corporate Architecture", May 1991.

[19]Rockville, Maryland site is contractor owned and will not be used for processing.

should be captured once at the source and then shared by all users. USACE will rely on the minimal essential data to get the job done. Data will no longer be redundant and unstandardized. The overall goal is to improve the accuracy, consistency, and timeliness of data, and to facilitate access to information.

2. Leadership Support and Executive Champions for Change

Leaders within USACE are actively involved in the modernization program, supervised by the Deputy Commanding General of the Army Corps of Engineers, the second highest ranking officer within USACE. As the senior IRM official, he has overall responsibility for information resource management.

Committees are an essential facet of the modernization program. The role of these committees is to drive USACE through its modernization effort. Critical to the success of the program is the participation by "executive champions" who are willing to take risks and make changes in the way USACE manages its information resources. USACE seeks out these committee members who are functional managers willing to try new methods and re-engineer business practices.

Figure 6 shows the committees and their functions. The senior governance board is the Information Resource Management Steering Committee (IRMSC). It is comprised of twelve voting members at the General Officer or Senior Executive Service level who are appointed by the Deputy Commanding General. Also included as non-voting members are the Program Managers for the Information Systems Modernization Program, the Hardware Acquisition Program, and the Director Of Information Management. The members of the committee are all top-level functional managers who make decisions for USACE. The Committee meets as required, but no less than quarterly.

The Executive Committee is a seven-member subset of IRMSC that meets weekly and is designed to "keep the pressure on" the program managers and the players in the modernization program.

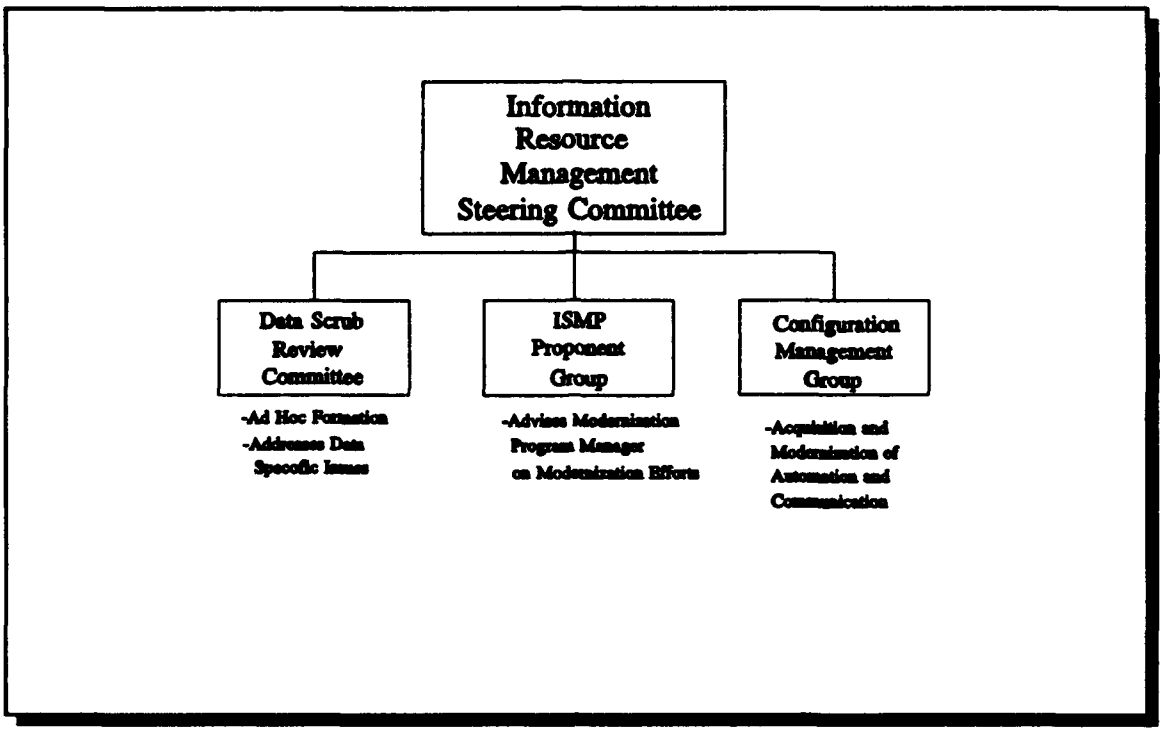

Figure 6. Information Resource Management Committees

There are three subcommittees operating under IRMSC. The Automation Configuration Management Board is chaired by the Director of Information Management and involves top management in the acquisition and utilization of automation and communications. The Data Scrub Review Committee consists of functional managers formed on an ad hoc basis to addresses data-specific issues within a given business process area. The final subcommittee, the Information Systems Modernization Program (ISMP) Proponents Group, advises the Modernization Program Manager on modernization efforts in all business areas.

E. Components of the Evolving Information Systems

The Corps of Engineers sees its future information systems evolving into five integrated application groups (Table 12). Of highest priority, Group One systems are those that have been initially identified as candidates for re-engineering (Table 11).

IS GROUPING	DESCRIPTION	APPLICATION*
GROUP 1	Drivers High degree of shared data Critical to USACE mission	Financial Management Payroll Real Estate
GROUP 2	Compliment Group 1 Subject Specific	Safety Information Management Database Navigable Waterways subject database
GROUP 3	Housekeeping Highly subject specific Broad Spectrum of business functions	National Inventory of Dams Career Program Management Database
GROUP 4	Decision Support	Executive Information
GROUP 5	Library and legal support	Historic Databases

* Representative listing

Table 12. USACE Information Systems Groupings

IV. USACE Re-Engineering Process

As a result of the modernization effort, USACE has developed an innovative approach to business re-engineering that results in the evolution of critical information systems in support of major business processes or missions.[20] The methodology incorporates the use of a technique adapted for USACE needs. The final result is a pragmatic and adaptive approach to IS development.

A. USACE - A Pragmatic Approach to Information Systems Development

As shown in Figure 7, USACE has outlined a strategy consisting of four major organizational activities and their IS counterparts.

1. ISP/ISPI Completion

The first step in any modernization program is the completion of strategic and tactical plans that form the foundation for business re-engineering. USACE strategy incorporates the use of the Information Systems Plan (ISP), and the Information Systems Planning Implementation (ISPI) report.

The ISP provides a strategic plan that relates information requirements to mission goals and objectives. An information architecture is defined, and an action plan recommending specific improvement activities is set forth.

USACE efforts included the use of the Headquarters level ISP, conducted in 1984, and 57 field level ISP's conducted between 1984 and 1989.

[20]With or without information systems support, the organization still has to deal with technical difficulties that are inherent in the way it conducts business.

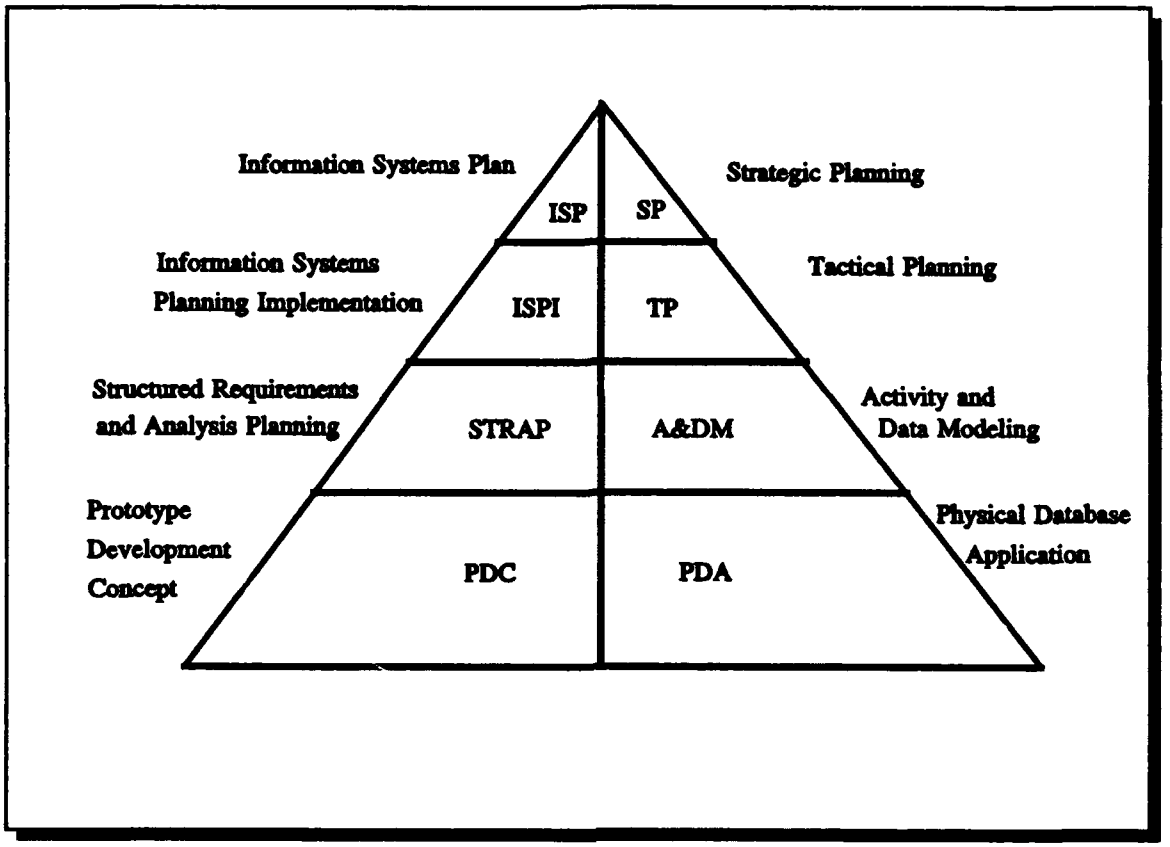

Figure 7. Mapping USACE IS Activities to Organizational Counterparts

Following the ISP, an ISPI is produced. This tactical plan establishes information architectures, creates project slates, and establishes the IS management structure. The ISPI project slate identifies candidates for re-engineering that form the foundation of the modernization effort. Again USACE efforts included both headquarters and field level ISPI's.

2. Business Re-Engineering Process Model — Producing the Structured Requirement Analysis and Planning (STRAP) Report

Process and data requirements of a particular functional application area are analyzed and documented in the Structured Requirements and Analysis Planning (STRAP)

Report. Producing this report uses a team approach that involves functional participation. Business activities are modeled, and result in a blueprint for further development. Figure 8 describes the business process re-engineering model.

a. Selection of Team Members and Team Composition

Once an existing application has been identified as a candidate for re-engineering, an application development team must be formed. The project leader is assigned approximately two weeks in advance of the start of the actual development effort to prepare for the task at hand. The project leader serves as both a working member of the team and as team leader, assuming a position of coordination between the team and the sponsor of the application being developed. This role calls for business system skills as well as effective leadership abilities.

Application development teams vary in size depending upon the application developed and the skills possessed by the various members of the team. In general, teams consist of six to eight individuals, with additional functional members on call to support the team if requested. STRAP team members are selected by the project proponents with the following used as criteria for team selection:

- A good working knowledge of USACE policies which impact their functional areas and a knowledge of USACE policies as a whole.
- Broad experience which transverses different functional areas and organizational levels within USACE.
- A manager or assistant in multidisciplinary area.

STRAP team members must be experienced with the overall mission and business practices of USACE. They must be willing to try new methods and apply innovative ideas to application development. Table 14 depicts the generic team composition and the roles fulfilled by team members. Most of the members come from USACE with a few

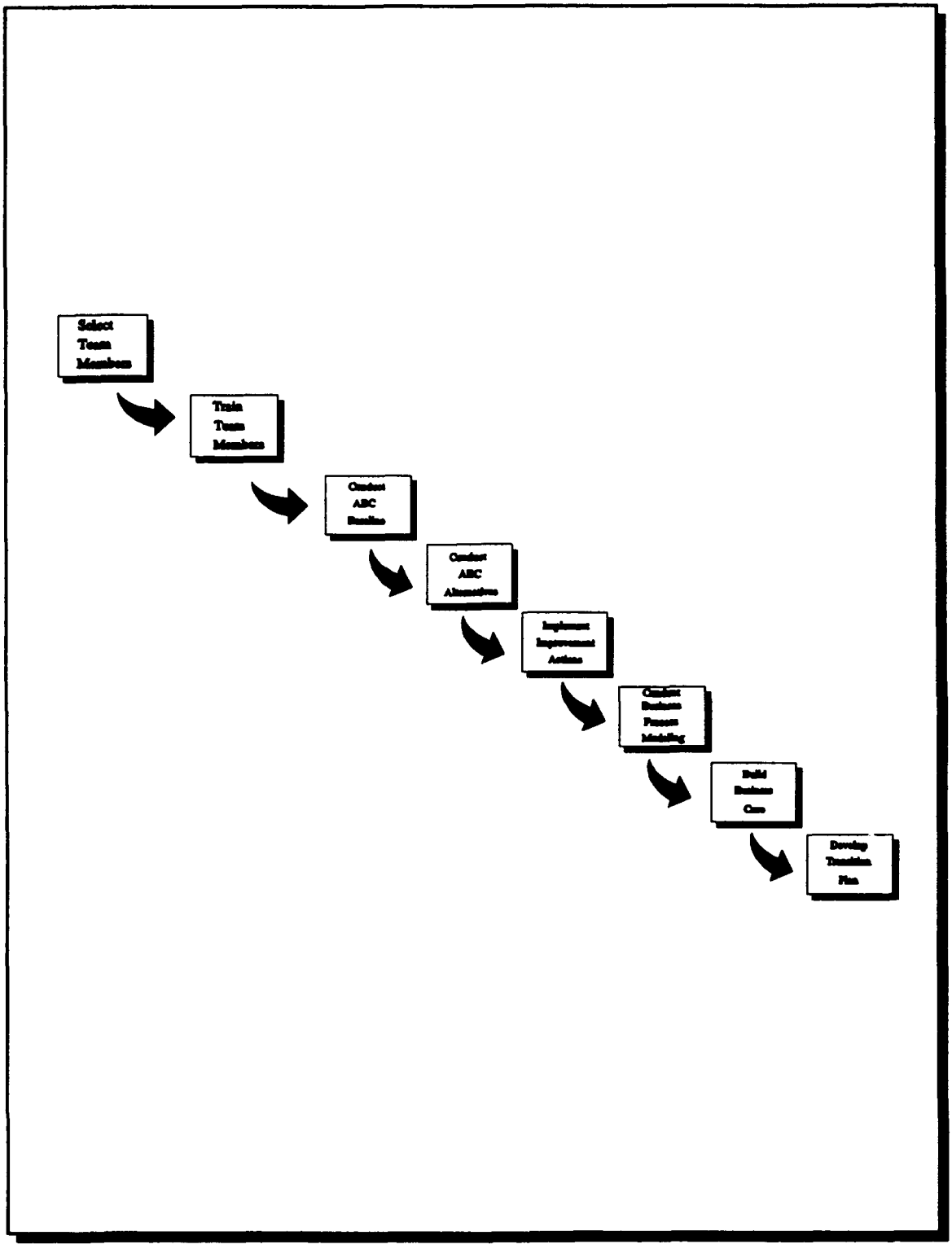

Figure 8. Business Process Re-Engineering Model

contractors providing instruction, modeling and administrative support.[21]

ROLE
• PROJECT LEADER
• FACILITATOR
• FUNCTIONAL USERS - SUBJECT MATTER EXPERTS - LIBRARIAN - USER MANUAL DOCUMENTER
• REVIEWER
• END USERS
• APPLICATION DEVELOPERS - TECHNICAL LIBRARIAN - USER MANUAL DEVELOPER
• HARDWARE/SOFTWARE SUPPORT
• DATA ADMINISTRATOR SUPPORT
• ADMINISTRATIVE SUPPORT

Table 14. Generic Team Composition

The *facilitator* is a USACE employee or a contractor knowledgeable in application development tools and techniques (i.e., IDEF tools and prototyping) and data-driven user-oriented information systems.

[21]"U.S. Army Corps of Engineers Information Engineering: Application Development Project Leaders Reference Manual", March 1, 1991.

A *functional user* must have a broad perspective of how the USACE conducts operations in his or her functional area. Users come from a wide range of management levels within USACE, and are key to the success of the application development process.

The *librarian* collects, catalogs, and maintains sample reports, documentation, and any references that a team may use during the development process. The *technical librarian* is responsible for the management of the software tools being used as the application modules are developed, and for keeping logs of the latest updates.

The *data manager* performs both data administration and database administration functions for the project. He or she maintains the conceptual data model as well as the physical model.

Application programmers should possess strong programming skills in high-level computer languages, particularly 4GLs or I-CASE products. They may be involved in the development of activity models with functional team members in order to gain an understanding of the relationships represented by the models. Programmers transform the functional description into the actual working application.

b. Training of Team Members

Team members must possess a wide variety of skills to ensure a successful application development effort. They must have knowledge concerning all phases of the application development process and the skills listed in Table 15. Each member need not possess all skills, and not every application requires all of these skills, yet they are representative of the skills required to develop an application successfully.

Team members initially were trained in modeling techniques and application development by personnel working under contract for USACE.[22] After this initial training, USACE uses its own personnel to train future team members.

[22]USACE training was conducted by D. Appleton Company. The approximate cost of this training (10-15 people) was $10.5K.

DEVELOPMENT PHASE	REQUIRED SKILLS
Planning Requirements and Design	•ISMP goals and objectives •LCMIS and information engineering •Application development project methodology •IDEF modeling techniques overview •USACE data administration goals and objectives
Development of Interactive Relational Database Information Systems	•Relational database concepts •Oracle and SQL for developers •COBOL programming for SQL databases •Oracle client server architecture
Data and Database Administration, Performance Tuning	•Oracle database administration, application tuning, and client server performance analysis •NOS/VSE file management optimization and communications in the client server mode
Functional User Design and Evaluation	•Introduction to SQL for end users •Oracle for end users •SQL forms and report writers for end users
Concepts and Operations of New Applications	•Conversion tool use •Manual conversion procedures •Overview of conceptual design of application •Procedures for the new application

Table 15. Skill Requirements

c. *Conduct Activity-Based Costing Baseline*

The main purpose of the ABC baseline is to acquaint members with the design tools (i.e., IDEF). Some participants are familiar with current business practices, operating procedures, and costs of activities. IDEF techniques are used to model these

processes ("AS-IS" models). This gives team members the opportunity to experiment and become proficient in IDEF modeling.

d. Conduct Activity-Based Cost Alternatives

After the business process is broken down into distinct activities in the "AS-IS" models, ABC is then used to analyze activity models (see Appendix B). Activities are determined to be either value-added or non-value added. A non-value added activity becomes a candidate for elimination or improvement. The results of the ABC analysis form the baseline for improvement action within the business process.

e. Implement Improvement Actions

An important step is to identify changes to the business process that can be improved without further analysis or approval. These improvement opportunities will be the foundation for the formulation of "TO-BE" process models which are formulated in the next phase of the business re-engineering methodology.

f. Conduct Business Process Modeling

Once the current system is analyzed and improvement actions identified, the team once again uses IDEF techniques to build "TO-BE" activity and data models of the system. These "TO-BE" models show how the business activities will perform once they are modernized. They are developed from the ground up with little or no reference to the existing process. Team experience and knowledge of the functional area being covered allow them to develop the future systems as they would like to see them operate. Usually, more than one "TO-BE" model is developed to examine alternatives before deciding on the final one. An initial data model is developed by extracting a subset of the command data model.[23] Additional data elements are added to the model

[23]The Command Data Model (CDM) is a graphical depiction of all USACE entities, data elements, and their relationships. This model is continually being developed as part of the overall modernization effort. The CDM provides the basic framework for all business systems

as necessary after approved by the Data Scrub Review Committee for use throughout USACE.

g. Build Business Case

The "TO-BE" models developed are now examined and evaluated. For each alternative, costs are identified, potential benefits determined, and risks assessed. This economic analysis serves as a basis for selecting the model to be developed.

h. Develop Transition Plan

The team must develop a project implementation plan. Included in this plan is the preferred project solution alternative and the reason for selecting it. The staging, resourcing, and sequencing of related actions are determined and a preliminary project schedule is drafted.

The final result of the business re-engineering methodology is the STRAP report. This report constitutes the foundation upon which targeted applications will be developed. It consists of the functional specifications of a proposed information system — i.e., the "TO-BE" activity model and its corresponding data model along with the proposed milestones for project completion.

4. Prototype Development Concept — from Design to Implementation

Prototype Development Concepts (PDC'S) are more technical in nature than the STRAP and provide the details necessary to actually build the systems defined in the STRAPS. The result is a fully working prototype that will be deployed for USACE-wide use.

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development depending on shared data.

a. Conceptual Design

Following the conceptual development and planning phase, functional requirements defined in the STRAP report are translated into a functional design description.

User application interfaces, bridges to other systems within USACE corporate architecture, and documentation of the necessary business controls are defined. The technical requirements for hardware, software, communications, security, and performance are also specified at this time.

Finally, the team surveys existing software applications that might be re-used as part of the proposed system. It also establishes guidelines for the procurement process if such an application is available and selected. No selection is made at this time as to whether or not an existing "commercial off the shelf" (COTS) application will be procured by USACE.

b. Acquire Application

The acquisition phase uses the design documentation and the list of existing available COTS applications to evaluate the packages available from commercial vendors or other government agencies. A Request-for-Proposal is drafted from the functional description and sent to potential COTS suppliers. Proposals received from suppliers are evaluated and the functional capabilities are compared with the requirements defined in the STRAP. The databases of the proposed systems are evaluated and a data model of the system is prepared to compare how thoroughly the proposed system databases meets the data requirements of the USACE model system. If an off-the-shelf system is selected, a contract for modification, transfer of technology, and maintenance is negotiated with the supplier. Eventually, the selected COTS system will become an integral part of the proposed system.

c. *Iterative Application Development*

If no COTS application meets USACE specifications a new application must be developed. Beginning with the functional description written during the design phase, a prototype of the application is developed. The key to the success of prototyping is to involve functional users in the continual evaluation and improvement of the system being developed. During this iterative process, users participate in the testing and evaluation of the emerging system, noting its deficiencies and suggesting design improvements. Corrections and enhancements are then made, and the improved version is resubmitted to users for evaluation. The functional description is updated to reflect the changes.

When all of the components of the application have been developed, they are integrated in preparation for "alpha testing" — i.e., internal systems testing. The functional description is updated and finalized, all program modules are recompiled and loaded, the test database and user documents are reviewed, and a proposed operations manual is drafted.

The integrated application undergoes a comprehensive functional test that encompasses user application interfaces, bridges to other USACE information systems, and the batch programs. Following the alpha test, an in-process review is conducted and the results of the testing are evaluated and necessary changes are made. Following this, approval is granted for advancement to "beta testing" — i.e., testing by a selected group of users.

d. *Perform Integration and Beta Testing*

The application is designed to fully integrate into the overall USACE architecture. Some integration is done during the system development, but final integration with the existing architecture is normally required.

Corrections, improvements, and enhancements that were identified during the alpha testing are programmed at this time. User documentation is updated to reflect these changes and the system is integrated with the Command Data Model. A second alpha test is then performed, and the system is also tested in the environment in which

it will operate. This testing aims to verify that the new application will operate in conjunction with existing systems.

Beta tests are performed in operational environments at multiple test sites. The new application is installed at a test site. Operators and end users are trained in the use of the application. The new application is usually operated in parallel with the existing information system or manual procedures. End users document any problems that arise as a result of the new application and evaluate the application in terms of effectiveness and performance level. Upon completion of the beta test, another in-process review is conducted and a recommendation is made for either deployment or continued improvement of the application.

e. Perform Operational Transition and Deployment

During the final phase of business re-engineering procedure the application is placed into operation.

A transition plan and deployment schedule is developed that considers issues such as the full-scale conversion of data, training of users, training of operations staff, bridging the system into currently existing systems, and scheduling the acquisition of hardware, software, and communications. Actual deployments at specific sites are scheduled at this time.

Following these steps, the application is packaged for delivery to end users. This involves preparing the necessary software, documentation materials, and training plan. When the package is delivered, the application development team turns over responsibility for management and maintenance to the appropriate support team. This team installs the actual hardware, software, and communications required at each site.

The final step in the implementation involves the training of site personnel, including both end users and operators, on the operation of the new application. In addition, local management is briefed on the scope and basic functionality of the application.

When the entire application is in place at a particular site, users will begin to operate the new system either in parallel with the existing system or independently as appropriate. The initial six-month period is used to provide feedback to the proponent in the effectiveness of the new application and to propose any major changes that may be necessary. Following this phase, the system is fully operational.

V. Lessons Learned

A. Top Management Support is Critical

The commitment and support of top management is critical to the success of any business re-engineering effort. Top management must see information as a strategic asset, link re-engineering to mission effectiveness, and fully support the efforts of the information modernization team. Any fundamental change in the organization is impossible without such support. As the second highest ranking officer within USACE, the senior IRM official possesses the authority commensurate with this responsibility to effect change within the IRM organization.

B. Business Re-engineering Drives Information Systems Design

USACE has determined that 85 percent of its improvement opportunities are related to the business procedures and not to automation alone. This is critical to understanding the importance of business re-engineering. Organizations are often enthusiastic about automation, yet they must realize that if the business processes underlying the automation effort are inefficient, the automation will be futile.

The goal of business re-engineering is to rethink the way an organization operates. Computer systems development can no longer be solely justified as a means of automating existing inefficient business practices. The systems must be designed to incorporate new and innovative business practices. These practices can only be discovered through an extensive business re-engineering effort.

USACE has demonstrated that successful re-engineering is dependent on an incremental and pragmatic approach to business process re-engineering. The business processes of the organization must be broken up into projects of manageable size. The

organization must not attempt to re-engineer without an understanding of the underlying business processes. When these processes are understood and have been redefined, they must be integrated with each other in order to form the overall business process for the organization.

A focus on business processes does not in any way minimize the critical importance of information technology. Although technology should not drive changes in business processes, it often enables changes that would otherwise not be feasible.

C. Use of Committees to Solidify Results

Teamwork constitutes the cornerstone of TQM. Committee-oriented decisions promote cooperation, non-hierarchical posturing, and effective problem solving. USACE has demonstrated adept use of the committee decision making process in the development of management information systems. Collaborative group work is especially suitable to re-engineer mission-essential applications.

The involvement of high level functional managers has proven to be a key to the success of the re-engineering effort. By bringing these managers together and forming a top-level decision making committee, priorities and functional specifications can be set to reflect the overall mission of the organization. Collectively, USACE's IRMSC and the associated Executive Committee and sub-committees determine the direction of future modernization programs.

D. Involvement of Functional Managers is Fundamental

Critical to the success of re-engineering is the active participation of functional managers in the process. Functional managers have a clear understanding of the business processes taking place. Their cooperation with the information resource staff significantly improves the quality of improvement and changes to the systems. New systems tend to be cross-functional and so it is necessary to get the joint participation of all functional managers whose areas of responsibility will be affected by a system change.

E. Role of a Consultant

Implementing a successful information system calls for a combination of a sound understanding of the business process and a strong grasp of the appropriate information technologies. It is fairly unusual for an individual team member to have solid credentials across this wide spectrum. The team as a whole typically encompasses the necessary business and technical skills, but it is not easy to integrate across such disparate individual backgrounds. A good consultant brings to a project a broad set of talents that supplement those of the team. The skills and experience necessary to do this well are quite rare. Therefore most projects cannot employ such a person on a full-time basis. A consultant, however, may be able to contribute concurrently to several projects, thereby leveraging his or her expertise in an effective way. These skills may be obtained from an outside consulting firm or, very often, through an internal staff having a similarly broad set of skills.

F. Role of Executive Champions

The role of "executive champions" is another critical success factor. Proponents of a modernization program must seek out managers at all levels who take risks and are willing to try new and innovative business methods. They must not be afraid to change the way they work and to change the way that information is viewed by the organization. The managers who realize that successful information management and data sharing are key to the increased efficiency of operations must be at the forefront of the modernization program.

G. Need for a Well-Structured Methodology and Training

A successful re-engineering effort is dependent upon the adoption of a structured information engineering methodology supported by a commercial-off-the-shelf (COTS) software tool that can be tailored to meet organizational needs.

USACE has demonstrated success in using the Structured Requirements Analysis and Planning (STRAP) methodology, a process in which the information requirements of a business are analyzed and documented, and has proven that it does provide a structured approach to the analysis of business processes.

Critical to the success of such a methodology is the training of the individuals who are involved in the re-engineering efforts. USACE experience has demonstrated the invaluable benefits of having trained team members in appropriate areas of systems development, particularly areas such as IDEF and ABC. Training and orientation require up-front costs, but the investment is essential.

H. Use of Activity-Based Management and Costing in Conjunction with IDEF Activity Modeling

ABC has been used successfully in the commercial sector. The experience of USACE has shown that DoD agencies can incorporate such a tool into a comprehensive business re-engineering methodology. This methodology is being exported as a standard throughout the Department of Defense.

USACE has demonstrated that ABC, used in combination with well-proven structured activity and data modeling techniques such as IDEF, provides a powerful tool for accomplishing business re-engineering. Structured techniques allow managers to simplify the view of the business process and to establish a well-defined audit trail to support the continuous review process. Furthermore, ABC techniques provide essential inputs necessary to identify activities that must be eliminated or improved.

I. Critical Role of On-Line User Support

The role of on-line user support is crucial to the future of systems development. Realizing this critical issue, USACE has designed its systems so that users of the systems are the direct recipients of the data. Whenever possible, the role of an intermediary — i.e., a computer operator — between the systems and the users should

be eliminated. Managers will have direct and fast access to the data critical to making timely and correct decisions.

J. Central Role of Data Modeling

As part of the USACE 1995 architecture goals, data are viewed as critical system resources. Consistent with this view, USACE has moved to data centralization and standardization. A system of reviewing and approving data elements was developed, it consists of three steps: submission of data elements, approval by the data scrub review committee, and certification as standard USACE data elements. Currently USACE has approximately 2000 data elements at the "approved level." These represent approximately 80 percent of the data elements that will be required by the 1995 architecture.[24]

Standardized data modeling has several advantages. During the data review process, USACE realized that over 40 percent of its current elements were redundant, causing added costs, errors, and inconsistencies. With data standardization, data are separated from applications, entered once at the source, and shared by all. By this means, the inconsistency and increased overhead associated with redundant data can be substantially reduced. USACE uses only the essential data to manage its information. This minimization of data elements improves information quality, timeliness, and access.

[24]Spivey Interview

CRITICAL ISSUES	USACE IMPLEMENTATION
LEADERSHIP	
• Senior Management Commitment	• Deputy USACE commander is senior IRM official
MANAGEMENT	
• Functional managers are key to success	• IRMSC comprised of top-level functional managers Application development teams involve middle-level functional managers
• Change Agents essential	• Executive champions sought at all levels
• Consensual decision making	• Use of committee work to solidify results
STRATEGY	
• Re-engineering effort operates as a natural business process	• Use of a well-established and comprehensive planning program
• Business process drives IS design	• Re-engineering business processes prior to automation
METHODOLOGY	
• Focus on business processes	• Use of ISP, ISPI, and STRAP methodologies
• Use of structured methodology that can be universally applied	• IDEF in conjunction with ABC
• Data modeling and standardization are essential	• Creation of the command data model and command data dictionary in conjunction with USACE data administration program

Table 16. Summary of Lessons Learned

Appendix A. An Overview of the IDEF Technique

IDEF (Integrated Computer Aided Manufacturing Definition) is a modeling technique used to graphically represent business processes. Based on Structured Analysis and Design Technique (SADT) developed by SOFTECH in the 1970's, IDEF is a structured and proven methodology that has been widely used throughout industry and government. IDEF refers to two diagramming methods. IDEF0 is used for functional activity modeling, while IDEF1X is used for data modeling.

The IDEF0 modeling technique was developed by the U.S. Air Force as part of their Integrated Computer Aided Manufacturing (ICAM) project. The goal of IDEF0 is to provide a graphical framework for hierarchically decomposing and representing the business process as a collection of related functions and activities.

Activities are the center of IDEF0. An activity is an action that occurs within a business process that has a recognizable outcome. Symbols are used to represent activities and information flows. Activities in IDEF are represented by boxes (Figure A1.) The text within the box is the name of the activity itself. Activity names are typically verbs or verb phrases. The arrows represent information flow and have specific meanings. Arrows entering the left side of the activity box represent *inputs* — those items which are consumed or transformed by the activity. *Controls* are represented by the arrows entering the top of the box and are those factors that constrain or influence how an activity is to be performed (i.e., existing regulations, prior personnel commitments). The right side of the box is reserved for the *outputs* or the product of the activity. The arrows entering the bottom of the activity box represent *mechanisms* — the people or tools used to perform the activity.

Collectively these information flows are referred to as "ICOMS" (derived from taking the first letter of the name of each information flow. All ICOM's are given a title

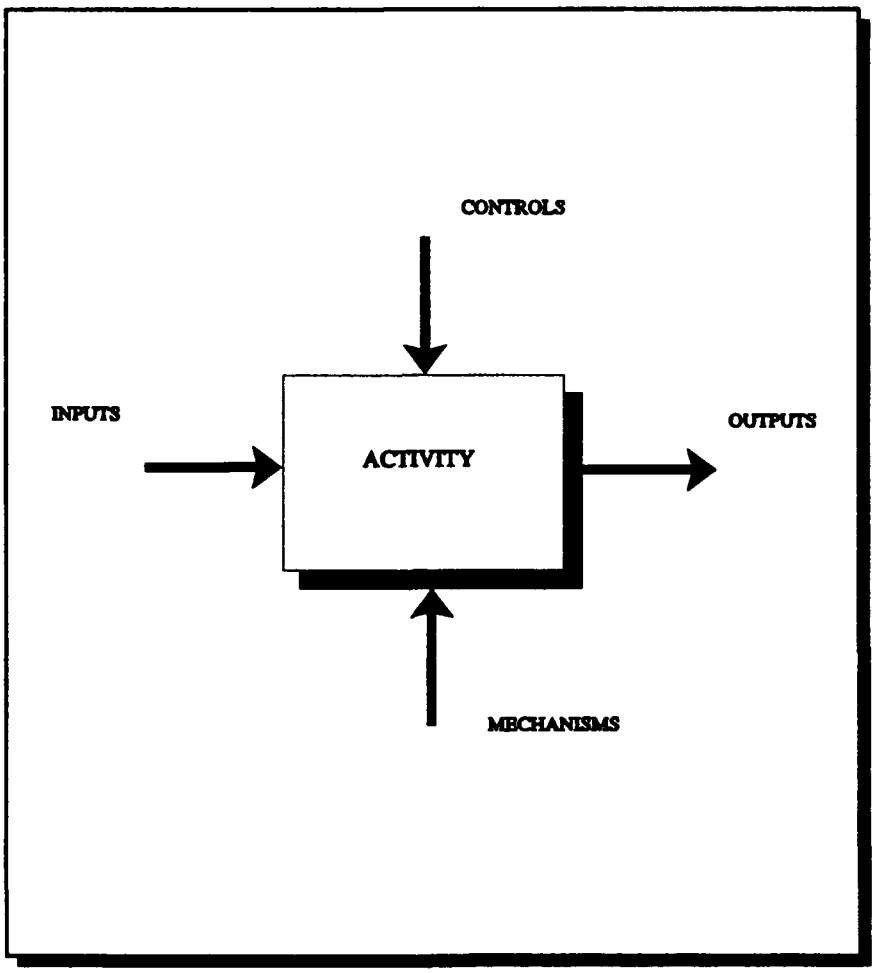


Figure A1. An Example of a Generic IDEF Activity Model

and a glossary defining each ICOM and activity accompanies the models. IDEF uses four types of activity diagrams to represent the business process:

- Node Trees (Figure A2) - A representation of the activities without the associated ICOM's. The dots on the tree represent an activity, while the lines of the tree represent a decomposition relationship between activities. A node allows the re-engineering team to see how the activities are related hierarchically, and to get an overall view of the business process. They can determine which activities are actually part of their program and which activities are outside the scope of their efforts.

- Context Diagrams (Figure A3) - A representation of the highest level activity and its associated ICOM's. The highest level activity is the entire process being modeled.
- Decomposition Diagrams (Figure A4) - A breakdown of the context diagram into subactivities and associated ICOM's.
- FEO (For Exposition Only) diagrams - Used to focus in on a particular portion of a decomposition diagram.

The ability of IDEF to decompose processes hierarchically is its strongest feature and makes it particularly suitable to re-engineering. Users of the IDEF modeling techniques can examine any portion of the business process in great detail since a given process can be broken down into several sub-processes. This feature allows the re-engineering team to view the complete business process in detail and to identify those non-value added activities that are the target for elimination in any program of re-engineering. IDEF can be used to model the "AS-IS" process from which the cost drivers are identified and then to model the "TO-BE" process with un-needed cost drivers eliminated and a more efficient process defined.

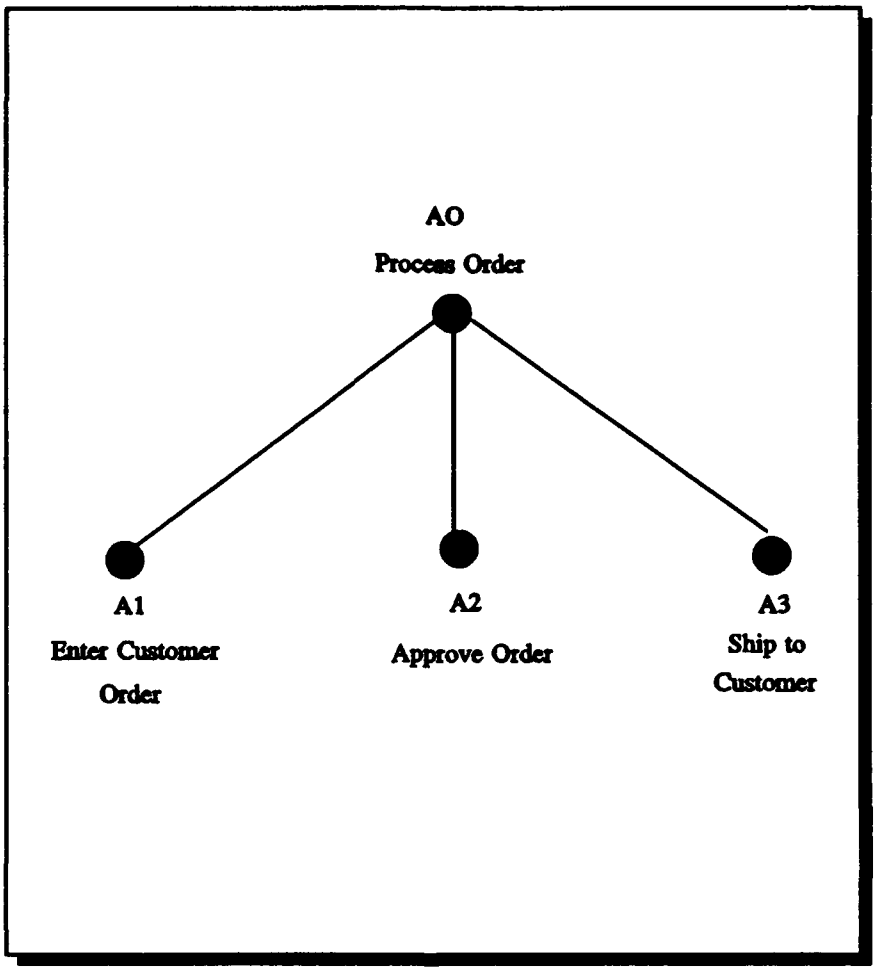


Figure A2. An Example of a Node Tree

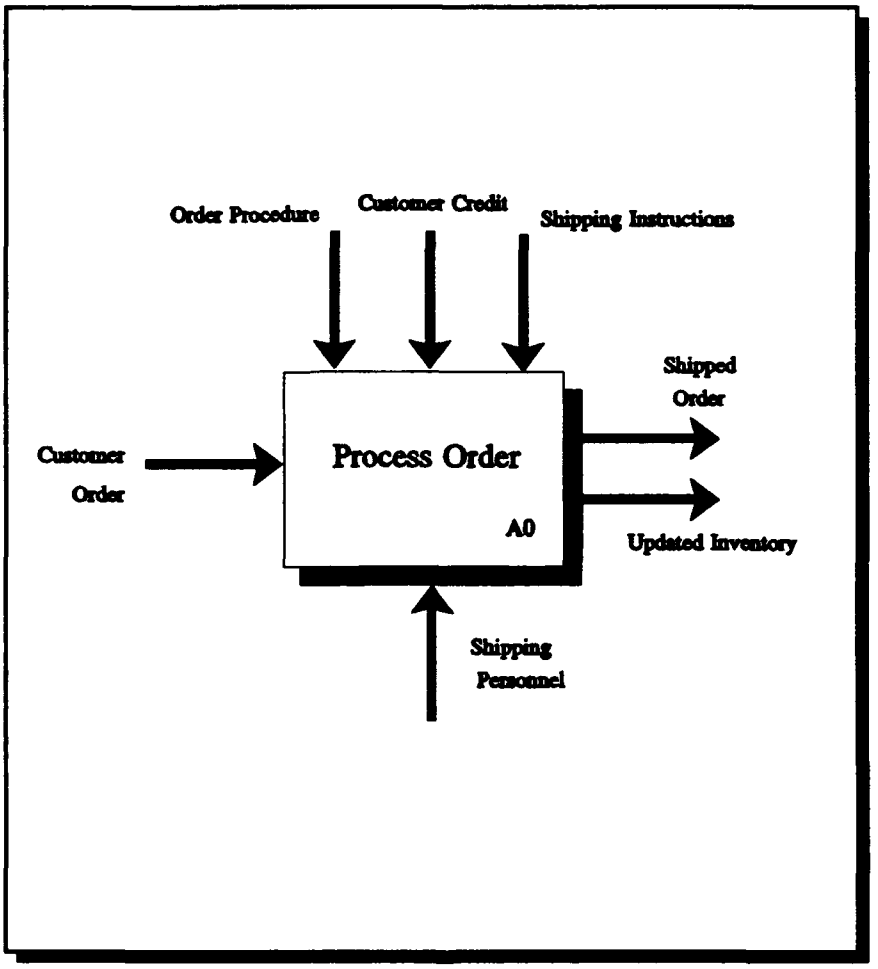


Figure A3. An Example of a Context Diagram

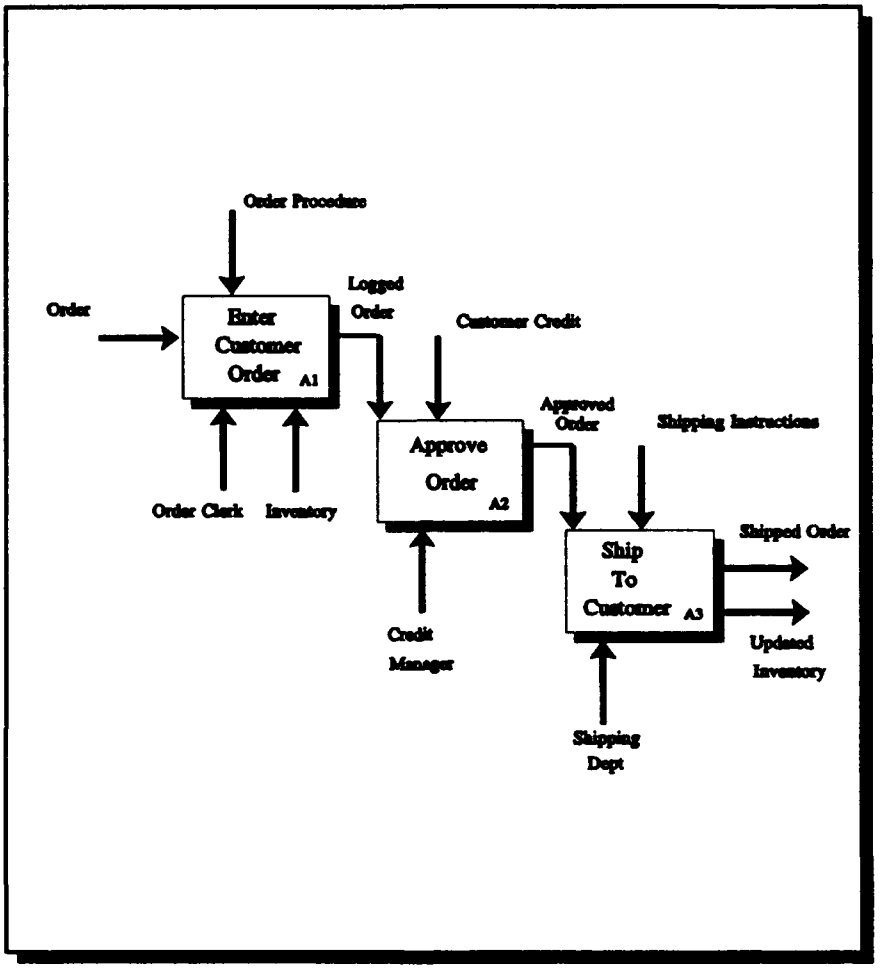
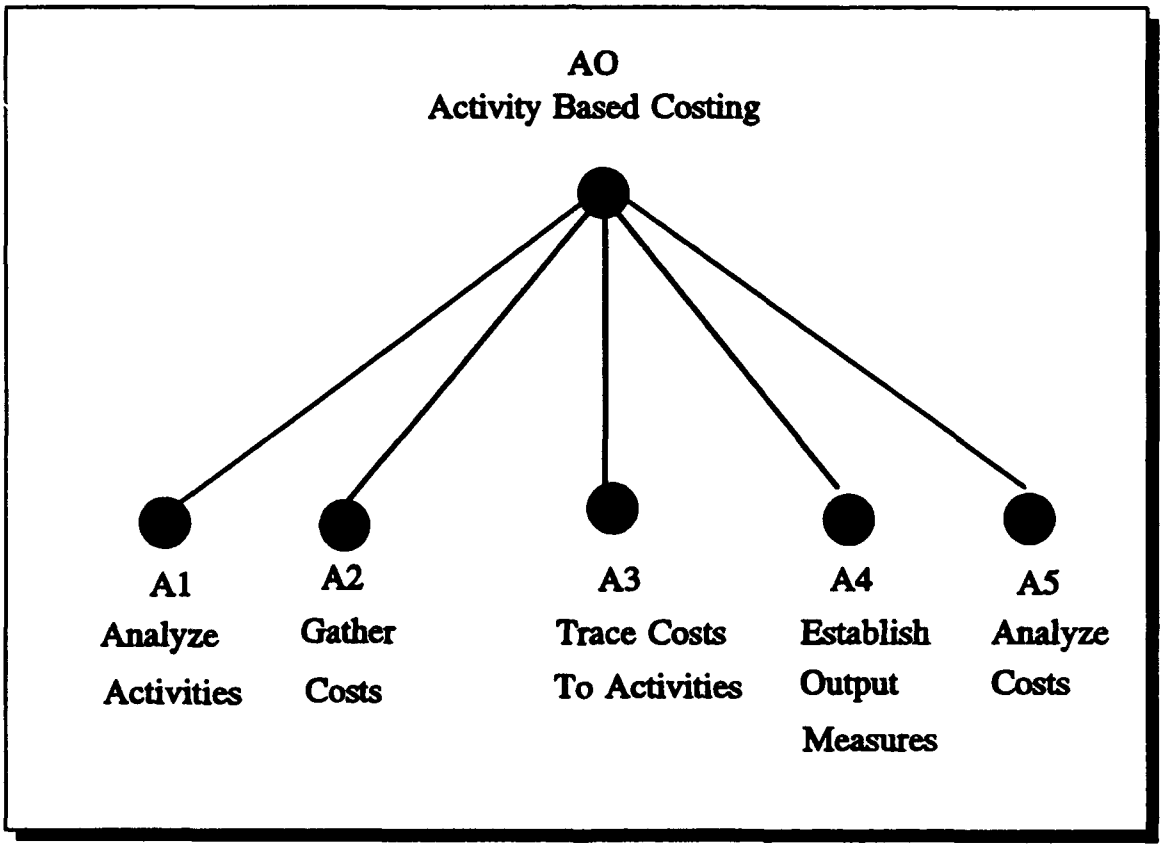


Figure A4. An Example of a Decomposition Diagram

Appendix B. Procedures for Activity Based Costing — Determining Activity Costs Through IDEF0 Modeling

ABC recognizes the causal relationships of cost drivers to activities. Practitioners of Activity Based Management (ABM) analyze activity costs and focus on the management of these activities. The goal is to improve the value received by the customer in terms of increased profit or benefits received.



ABC used in conjunction with IDEF0 modeling brings together the factors necessary to aid decision makers in identifying and implementing improvement opportunities. ABC consists of fives phases (Figure B1). Each phase is accomplished in sequence by a small group of persons called the *team* to establish a baseline for activity cost performance. Once trained in the techniques of breaking down activities into cost factors the *team* assists functional users in gathering costs, defining activity-cost concerns, and constructing ABM cost databases. Once a validated cost database is established, updating cost data becomes an easy task to be performed on an annual basis.

A. Analyze Activities

Operating management decides the scope of activities, often numbering in the dozens, to be analyzed. The program should encompass six to ten units within the organization that have common functional areas stemming from the same budgetary appropriation. IDEF0 is used to create "AS-IS" models of the business process. The activities identified through this modeling technique are those which form the foundation for ABC analysis. These models are validated and processes analyzed to characterize activities as either value-added or non-valued-added.

B. Gather Costs

At the same time activities are analyzed the Team examines historic data to collect cost information associated with the business process. These costs will later be traced to specific activities to facilitate the identification of cost improvement opportunities.

C. Trace Costs to Activities

This phase merges the results of activity analysis and cost-gathering to produce an input cost for each activity. It is these input costs that are used as part of the output measure.

D. Establish Output Measures

The next step is to calculate the activity unit cost. One primary output must be identified for each activity. The output must be quantifiable. Activity unit cost is determined by dividing the input cost by the output volume.

E. Analyze Costs

Analyze costs uses information derived from the previous phases to determine improvement opportunities. Non-value-added activities are identified and become candidates for modernization or elimination.

Glossary of Terms

ACTIVITY - A business process, function, or task occurring over time with recognizable results. Activities are represented in an activity model with identifiable inputs, controls, outputs, and mechanisms.

ACTIVITY-BASED MANAGEMENT (ABM) METHODOLOGY - A prescribed process that puts activity-based costing (ABC) theories into practice. It includes the breakdown of an enterprise into manageable segments for detailed analysis regarding cost and performance, aimed at effective and consistent organization of the enterprise's activities, continuous process improvement, and the elimination of waste.

ACTIVITY MODEL - A model that describes the business activities for a particular environment. The activity model depicts how activities relate to one another and the use of the environment in a pictorial format with various levels of detail.

ACTIVITY MODELING TECHNIQUE - A technique that defines both the AS-IS and TO-BE environments. This is a description from the external user's view.

ACTIVITY OUTPUT - The product of an activity. What internal or external customers receive and what the organization produces — e.g., a paycheck, widget, or some type of service.

ACTIVITY PERFORMANCE MEASURE - A quantifiable measure of the cost of performing an activity, a measure of time required, and how well an activity was performed.

ALPHA TEST - A set of scheduled internal tests to demonstrate the correctness and completeness of conceptual logic models, internal physical database models, application development projects, user documentation, and Standard Operating Procedures (SOP's) within normal limits.

APPLICATION - The user's interface into the system, the window into the database. The User Interface Application requirements defined in the conceptual design are the actual application components that provide service to end users.

APPLICATION DEVELOPMENT TEAM - A group of functional users and technical specialists whose primary function is to oversee the requirements specification, design development, programming and implementation of a information systems application.

AS-IS MODEL - A diagrammatic illustration of the business process as it currently exists.

BETA TEST - The Beta Test is a normal working environment test. It is a user software acceptance test of a new system or changes to a deployed system. The Beta Test is conducted in a field environment using a production "live" database executed on designated hardware.

BUSINESS PROCESS - A group of logically related decisions and activities required to manage the resources of a business. The linkage of activities across functional boundaries.

CASE (Computer Aided Software Engineering) - Collective reference to a family of software development productivity tools.

CIVIL WORKS PROGRAM - Major USACE mission area that includes water resource management and emergency response programs.

COMMAND DATA MODEL - A fully attributed conceptual data model that is the overall logical structure of the Corps of Engineers data, independent of any software or storage constraints. It may often contain data structures not yet implemented in internal/physical data models.

COST DRIVER - Factors of an Activity that lead directly to expenditures and create costs.

DATA - Meaningful facts about persons, places, things, concepts, events, and activities in a defined format and structure from which information may be derived.

DATA ELEMENT - A property or characteristic of a real world object. A data element has a name and a definition. Data elements are used to distinguish between real world objects and to provide descriptions of them. Data elements are named with singular nouns.

DATA MODEL - A model that described real world objects, their data elements and relationships that comprise the data that describe the business environment and support the activity model.

END USER - A person who uses the information or data provided by a computer system. For example, engineers, secretaries, and managers are all end users.

FOURTH GENERATION LANGUAGE (4GL) - Programming language that uses high-level human-like instructions to retrieve and format data for inquiries and reports.

FUNCTIONAL USER/CUSTOMER - The responsible Corps individual who oversees and manages an Application Development project or a STRAP.

GAO/IMTEC - General Accounting Office Information Management Technology report.

IDEF (Integrated Computer-Aided Manufacturing Definitions) MODEL - A semantic language based representation of complex real world activities and their interdependencies. These interdependencies are classified as either inputs, controls, outputs, or mechanisms (ICOMS). IDEF models provide an understanding of the activities in the environment and their use of information.

IMPROVEMENT OPPORTUNITIES - Identified during the definition of the AS-IS Model, they represent the areas of importance to be focused on during the To-Be modeling process.

IN-PROCESS REVIEW (IPR) - A review by a team of functional and technical delegates to determine if the requirements of a business area are being satisfied in an efficient manner by the Application Development effort.

INFORMATION RESOURCE MANAGEMENT STEERING COMMITTEE (IRMSC) - Made up of the senior personnel from the major directorates and offices in the Headquarters to be concerned with strategic issues (such as appeal on data naming issues).

ISP - Information System Plan

ISPI - Information System Planning Implementation

LIFE CYCLE MANAGEMENT - The control and administration of an information system throughout its entire existence, from system development to replacement.

NON-VALUE ADDED ACTIVITIES - Anything other than the minimum amount of equipment, materials, space, and employee essential to achieve corporate objectives and remain an ongoing enterprise (e.g., correction, inspection, expediting delay, storage, etc.).

PROCESS MODEL - Pictorial representation of logically related decisions and activities using an accepted modeling technique.

PROPONENT - The USACE organization that is responsible for the definition of the entity and/or data element.

STOVEPIPE SYSTEM - A separately developed information system without shared data and/or resources.

STRAP (Structured Requirements Analysis and Planning) Report - Process and data information requirements of a business are analyzed and documented. A Business Process is selected from those projects slated during Information Systems Planning Implementation (ISPI). The overall information requirements are identified and projects proposed to implement these needs.

TO-BE MODEL - Diagrammatic illustration of the incorporation of business process Improvement Opportunities with the Command Data Model concept of shareable data across business processes.

VALUE ADDED ACTIVITIES - Contribute to the achievement of enterprise activities and/or to product attributes and service level paid by the customer.

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